Light and Lighting

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Office Lighting

AT last the reconstruction of the devastated business area of the City of London is gathering impetus. Some fine blocks of offices are under construction, such as the one which will cover the site of the Mithras temple so recently uncovered. Others are planned, including a skyscraper of 27 floors. We can hardly doubt that these new offices will be better lighted than their predecessors. They should, indeed, be far better lighted, and it is reasonable to hope they will afford a shining example of office lighting practice at its best. Much water has flowed under London Bridge since Bob Crachit—immortalised by Dickens in "A Christmas Carol"—worked as best he could by the flickering light of a candle in old Scrooge's office. We can be thankful for the substantial advance in office lighting which has been made since Dickens's time—an improvement which the reformed Scrooge might himself have welcomed. However, there is need for a much more general application of good lighting to offices throughout the country. Impending legislation may stimulate action towards improvement where it is most needed, but it is by example and persuasion that a wide extension of the best practice is to be looked for.

Notes and News

The Solar Eclipse

The solar eclipse on June 30 last was total over a band crossing the southern part of Sweden and Professor W. D. Wright was in charge of a party from the Imperial College who journeyed to the little town of Grebbestad, on the Skagerrak some distance north of Gothenberg. There they set up a semi-portable tristimulus colorimeter and used it to measure changes in the colour of the sky during the course of the eclipse.

A very interesting, and frequently entertaining, account of the expedition was given by Professor Wright to the members of the Physical Society Colour Group at their meeting on October 6. He explained how the instrument he used was one of a pair, designed and constructed at the Imperial College at the suggestion of Professor S. Chapman, and originally intended for measuring the colour of the aurora, more particularly during the Geophysical year of 1957-58.

After construction had been started, it was suggested that the instruments might be used to measure the changes in the colour of the sky that were expected to take place during a total solar eclipse. The second instrument was taken by Mr. McInnes of Edinburgh University in a plane that flew along the totality zone near Iceland.

Many were the pitfalls encountered in making measurements of such rapidly changing phenomena as those which occur during an eclipse and not all of these were avoided, especially in the excitement of making observations during flight. Nevertheless some very interesting information was obtained; in particular, it was found that marked colour changes only occurred within about 10 deg. of the horizon. The average sky luminance during totality was found to be about 0.11 cd/ft.^{2}.

The Motor Show

The 1954 Motor Show recently held in London was said to be the biggest and brightest for years. The cars on show certainly seemed bigger and more beautiful than ever, but as there is little point in our looking at things we cannot afford we spent most of our time at the show on the main purpose of our visit which was to see what attention the motor industry is giving to the matter of visibility from the driving seat.

Much is said, and done, about lighting up the roads at night so that drivers can see where they are going, but we have a feeling that not quite so much attention is given to enabling drivers to see the road when it is lit up. It seems to us that low-slung driving seats must restrict the driver's view of the road ahead and must have some adverse effect on road accidents. A leaflet on the stand of the Road Research Laboratory dealt with the matter of visibility from the driver's seat and one of the points made on the leaflet was that drivers should make sure that they are high enough; it is recommended that if necessary a cushion should be used to raise the seat. True there are tall people and short people, but surely the car manufacturers themselves could make the driving seat so that it can be adjusted so that even a short driver can arrange it to see through the windscreen without effort; one only has to watch cars on the road to see that drivers just don't bother with cushions. Drivers of buses and lorries are not allowed to loll back but have to sit almost bolt upright, and care is taken in the design of their vehicles that they have a good view of the road immediately in front. Super-streamlining is all very nice, but it should take second place to safety. The Rolls-Royce car looks very nice (it still looks like a car) it is not low slung and the driver has to sit up, though still in comfort, so that he can see the road.

The stand of the Motor Industry Research Association also dealt with visibility from within the car and gave an effective demonstration on the design of cars to allow drivers a good view of the road. This stand and that of the R.R.L. we found the most interesting in the show, but as the stands were small and only a few people at a time could see the demonstrations we doubt if very many of the thousands that visited Earls Court actually saw them. The R.R.L. demonstration was a most convincing one on the need for correctly adjusted headlamps—and incidentally showed that yellow headlamps have no advantages. (A report on this by one of the staff of the R.R.L. was published by us in a recent issue.)

We wanted to see the u.v. illuminated speedometer dial on the new Sapphire, but unfortunately as batteries are not allowed on the cars in the show it could not be demonstrated. This seems a bit of unnecessary gadgetry; and if there is any stray u.v. about drivers may find it a nuisance.

The dome of the Sistine Chapel at S. Maria Maggiore in Rome. See article on following pages.

Interior Lighting in Italy

BY VIRGILIO BENZIO*

A brief review of interior lighting practice in Italy including descriptions of some typical installations.

After the war as fluorescent lamps became generally available great progress was made in lighting techniques in Italy as was the case in many other countries. Fluorescent lamps by reason of their higher efficiencies, long life and low intrinsic brightness became increasingly used for interior lighting in shops, offices, factories, theatres and many other places. Occasionally, it is true, these new lamps were used just for the novelty and were used without due regard to technical and economic considerations; nevertheless there is in Italy no lack of installations in which fluorescent lighting has been used with complete success.

Industrial Lighting

In Italy electricity for lighting purposes is very expensive being subject to a special tax. It is natural, therefore, that in the industrial field fluorescent lamps should be widely adopted. The exception is in the case of high bay areas where mixed lighting with tungsten lamps and mercury lamps is used; for such applications the improved colour fluorescent bulb lamps recently made available are also being used.

Illumination levels are also increasing and where 2-3 lm./ft.^{2} were used pre-war levels of 5-10 or even more are now common. Such levels are, of course, well below those recommended in the United States or in Britain, but progress is constant and encouraging. In addition we are not only increasing illumination levels on the working plane, but are paying attention to such matters as the general surround brightness and the colours of walls, ceilings and of machines. Uniformity of illumination, brightness of the light sources and the need for regular maintenance are also receiving attention.

The luminaire most commonly used for industrial lighting is the open-end reflector with 40-watt pre-heat type lamps though the instant start slimline lamps have of late met with a certain amount of favour. A brief survey of some typical industrial installations may give an idea of what has been done.

In the loom section of the weaving mill of De Angeli & Frua of Gerenzano, Milan (Fig. 1) continuous lines of reflectors fitted with 40-watt white lamps mounted 3.20 metres above the floor and three metres apart have been installed. The installation was designed to give an average of 20 lm./ft.^{2} in service, the initial measured illumination being 24-28 lm./ft.^{2}. In other sections of the same mill (Fig. 2) use has been made of separate luminares, usually two 40-watt lamp reflectors with the lamps connected to different phases of the three-phase distribution system to eliminate possible stroboscopic effects. (This system is found to be more effective than that using lead-lag ballasts.)

An example of another type of installation commonly found in Italian factories is that used in the apparatus shop of the Campagnia Generale di Elettricita, Milan (Fig. 3). In this case the lamps are mounted in industrial type reflectors at 3.50 metres above the floor at three to four metre centres; this gives a very even horizontal illumination of 8 lm./ft.^{2}.

When fluorescent lamps first came along quite a number of installations were carried out in which bare lamps were fixed direct on to the ceiling. It was soon found, of course, that in spite of their low intrinsic brightness, lamps used in this way could become a source of considerable glare. On the other hand, such installations had the advantage that the ceilings also were illuminated, thus providing a brighter and more comfortable background.

For high bay installations (usually considered as those in which the mounting height is over 10 metres) mercury and tungsten lamps are generally used with approximately equal light output from each type of lamp. Excellent results, however, have been obtained using fluorescent slimline lamps, and recent installations of the 400-watt improved colour mercury-fluorescent lamps have been very favourably commented upon by factory engineers and executives.

Decorative Lighting

By "decorative lighting" I include not only installations of a purely artistic character or lighting for effect

* Compagnia Generale di Elettricita, Milan.

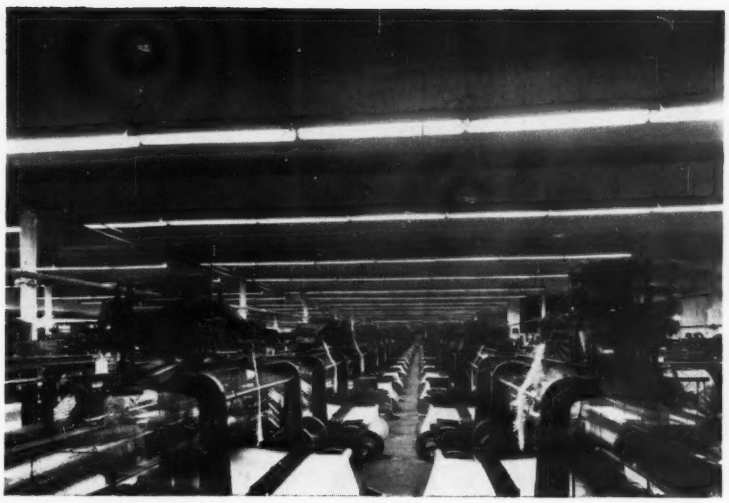


Fig. 1. Fluorescent lighting in the weaving room of a cotton mill.

Fig. 2. Fluorescent lighting in a warping room using twin-lamp industrial luminaires.

Fig. 3. An example of fluorescent lighting in an electrical apparatus factory.

Fig. 4. The nave of S. Maria Maggiore in Rome, the ceiling of which is illuminated by reflector spot lamps. (Note in this photograph and those which follow how the lighting shows up the details of the decoration.)

but also those installations where functional requirements have to be met and where it is essential at the same time to satisfy certain aesthetic and decorative requirements.

Such an installation which is really outstanding is that carried out at the basilican church of Santa Maria Maggiore, Rome, in 1949. The first task when designing this installation was to decide the illumination levels required in each part of the church, bearing in mind that the lighting must be adequate and comfortable and economic. For the main body of the church it was decided to use tungsten lighting for the nave (Fig. 4) and fluorescent lighting for the aisles (Fig. 5). This plan gave rise to quite a lot of discussion as it was thought by some that the fluorescent lighting in the aisles would have a cold appearance which would contrast unfavourably with the tungsten lighting in the nave; however warm colour fluorescent lamps were used and by shielding them carefully and avoiding bright spots on the stucco of the flat arches a result was obtained which satisfied even the most exacting critics.

In the nave different illumination values were used for the different parts of the walls and ceilings so as to give due prominence to the various works of art, mosaics, and

reliefs; the gilded and deeply carved ceiling needed particularly careful attention. The illumination values provided were :—

Mosaics on the apse	17	lm./ft.²
Mosaics on the walls	15	„
Mosaics on the main arch	15	„
Ceiling panels	20	„

To give the desired results use was made of 300-watt reflector spot lamps having a beam spread of 30 degs., which have the advantage of taking up very little space and therefore can be easily hidden. The lamps were installed along the entablature above the columns at a height of 9.50 metres above the floor and at a depth of 40 cm. from the edge. Each lamp had to be given individual adjustment, and the aiming point in some cases was as much as 80 metres distant. The number of spot lamps used to light the different parts of the nave is as follows :—

Side walls	80
Walls over the entrance	12
Main arch	12
Apse	20
Ceiling	56

Though from the purely lighting point of view normal

Fig. 5. One of the aisles at S. Maria Maggiore. Fluorescent lamps are concealed in the cornice.

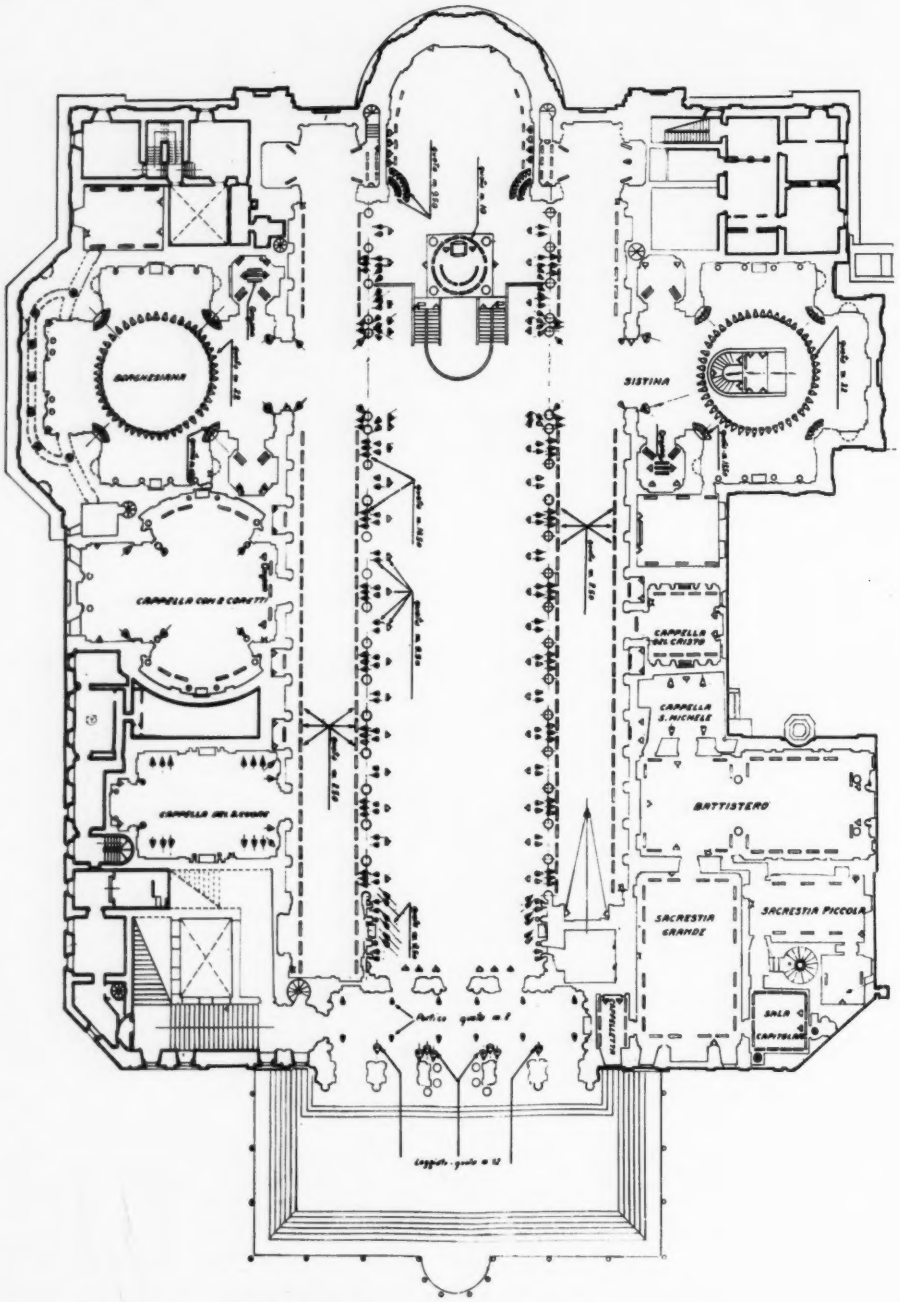


Fig. 6. Plan of S. Maria Maggiore showing positions where tungsten lamps (⍾) and fluorescent lamps (▭) are used. The interior of the church is 279 ft. long. (The height [quota] of lamps above the floor is shown in metres.)

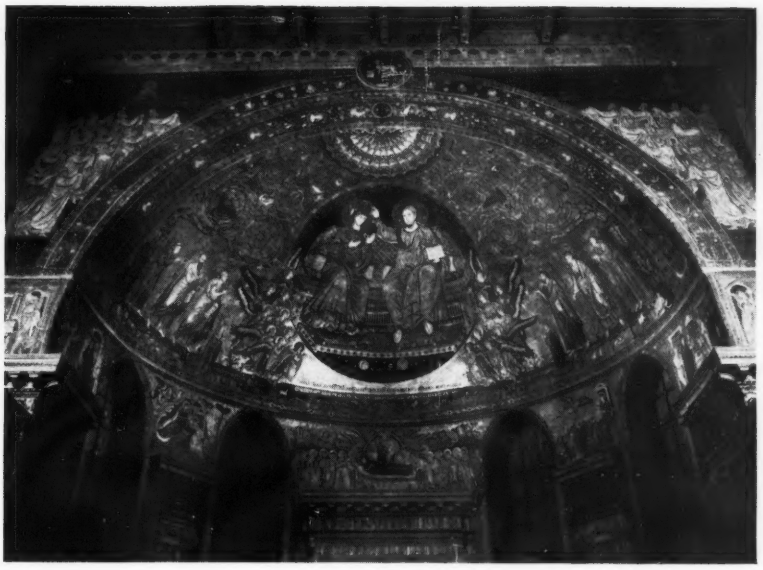


Fig. 7. The apse of S. Maria Maggiore, which is also lighted by reflector spot lamps.

floodlights might have done the job equally well, they could not be used because of their excessive dimensions.

Another equally interesting problem in the church of S. Maria Maggiore was that of lighting the Sistine and Borghese Chapels. These chapels are famous above all for their superb architecture and their fresco painted domes. To give prominence to these domes (See p. 359) a totally indirect system of lighting was installed such that the illumination inside the dome gradually increases from the bottom upwards. This has the effect of accentuating the height of the dome; at the same time sufficient light is reflected from the interior of the dome to give adequate lighting on the floor beneath.

For the interior of the domes use has been made of 150-watt projector spots which have a very narrow beam angle. The number of lamps used in each of the two chapels is as follows:—

For the crossing below the dome—28, 300-watt reflector spots installed in four groups of seven at a height of 13.50 metres.

For the dome—50, 150-watt projector spots mounted on the cornices of the barrel base at a height of 22 metres.

The illumination obtained is:—

On the crossing ... 15 lm./ft.^{2}
On the dome ..... 35 lm./ft.^{2}
On the floor ..... 2 lm./ft.^{2} (indirect contribution from the ceiling and walls).

Similar techniques have been used for other parts of the church; wide use has been made of indirect lighting and where this has not been possible care has been taken to shield light sources so as to avoid glare.

The total lighting load for the church is 180 kw., which is distributed from the main switchboard to six control panels. Normal lighting is controlled by local switches, but the special feature lighting is controlled by remote switches from the main switchboard.

An example of the type of installation in which the

decorative element takes precedence over functional requirement is given by the lighting of the public rooms in passenger liners. In most modern Italian vessels lighting is usually of the indirect type from cornices which form an integral part of the architecture; Figs. 8 and 9 show two of the public rooms on the motor ship *Sardegna*. As a rule direct lighting is used only for the lighting of murals, card tables and in bars. Levels of illumination provided vary from 5 to 15 lm./ft.^{2} according to the type of room. Fluorescent lamps are widely used for ship lighting, and being on D.C. have linear tungsten lamps in series as ballasts. This combination of light sources results in a very pleasant warm colour, as well as having the advantage of increasing the overall luminous efficiency.

Innumerable other installations of this kind have been carried out, particularly in cinemas and theatres. Fig. 10, which shows the auditorium of the "Medica" Cinema at Bologna, gives an idea of the current trend in auditorium lighting. In this cinema the foyers, corridors and the ground floor of the auditorium are lighted indirectly by means of fluorescent lamps concealed in cornices round the walls. Additional lighting in the auditorium is provided by four large semi-direct type luminaires on the ceiling designed to be in keeping with the general architectural style of the interior. It will be seen that on each wall there are also four artificial windows; these are lighted by fluorescent lamps behind the glass (Fig. 11) and give the impression of flooding the room with daylight from outside. The actual brightness of these artificial windows is proportioned to that

Fig. 8. The first-class lobby of the motor-ship "Sardegna."

Fig. 9. The smoking room of the "Sardegna."

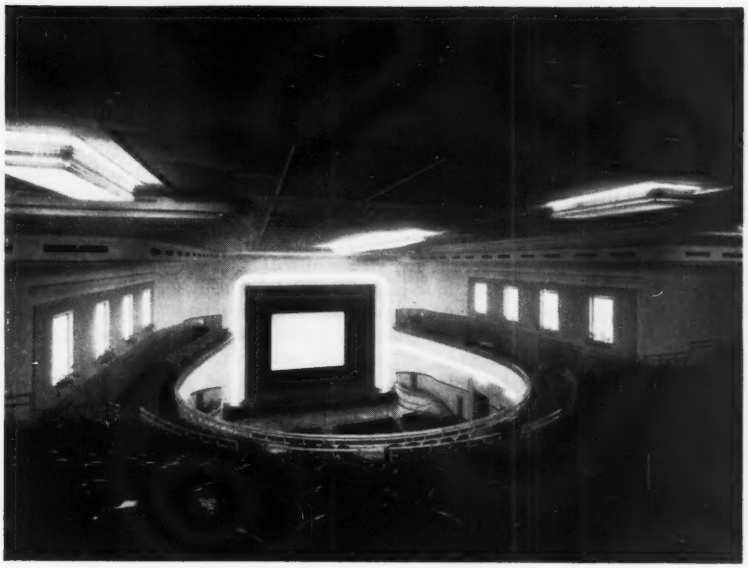
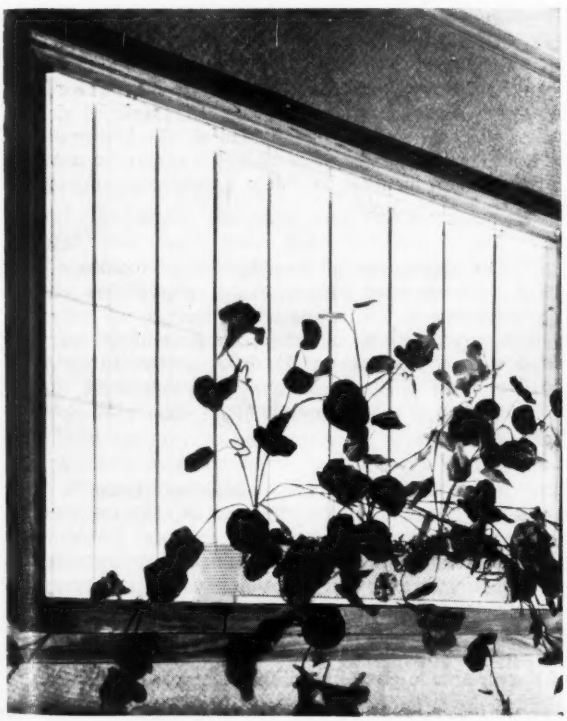


Fig. 10. The auditorium of the Medica Cinema at Bologna.

Fig. 11. One of the artificial windows in the auditorium of the Medica Cinema.



of the walls rather than to the actual brightness which would be obtained with real windows; in this way it has been possible to achieve a good standard of visual comfort without detracting from the psychological effect which is dependent to only a small extent on the absolute value of brightness. The illumination levels in the cinema are: foyer, 8-12 lm./ft.^{2}; corridors, 1-2 lm./ft.^{2}; and in the auditorium, 4-5 lm./ft.^{2}.

Conclusion

In this article it has been possible to give only a general picture of interior lighting development in Italy, and it is not suggested that anything included is particularly original. There is continual development in all fields of interior lighting and new ideas are always being tried out, often with good results. Lighting of stores and shop windows has not been mentioned, but an appreciation of the importance of lighting in shops is growing—and resulting in quite an important supply load as well as a welcome market for lamps.

I hope, however, that this short article will give some idea of the progress of interior lighting in Italy, even though our progress is in many ways similar to that which is going on in other countries.

The author wishes to thank Mr. Picconi of the Compagnia Generale di Elettricita, Rome, for having supplied data, diagrams and photographs relating to the lighting of S. Maria Maggiore.

Lighting Abstracts

OPTICS AND PHOTOMETRY

110. Standards of light 535.241

JEAN TERRIEN. *Bull. Soc. Franç. Elect.* 7th Series, **4,** 463-468 (*August,* 1954). *In French.*

Describes the history, construction and use of the primary standard of light; secondary standard lamps giving light of colour temperature 2042 deg. K.; secondary standard lamps of colour temperature 2353 deg. K., standardised from the former by the use of standard blue-glass filters; standards of flux at 2353 deg. K. (vacuum squirrel-cage construction), and 2788 deg. K. (gas-filled coiled filament construction) and their methods of standardisation. The agreement between the different national laboratories of the six countries in which the primary standard has been realised is better than 1 per cent., and the values published by the Bureau International des Poids et Mesures indicating the relative values of the candela and the lumen are correct to within 0.3 per cent., as represented by the lamps sent by the different countries. Possible improvements are discussed in construction of standard lamps, methods of heterochromatic photometry and in the primary standard of light, which might be improved by increase of its colour temperature by the use of, for example, iridium. J. M. W.

535.215

111. Principles, construction and applications of photomultipliers.

R. CHAMPEIX AND P. MARCHET. *Bull. Soc. Franç. Elect.* 7th Series, **4,** 448-462 (*August,* 1954). *In French.*

The principles, construction, performance and some applications of photomultiplier cells are discussed under the following main headings: principles, qualities and defects of photomultipliers; fabrication and testing; applications. J. M. W.

628.93

112. Use of high-speed computing devices in photometric calculations.

G. A. HORTON. *Illum. Engng.,* **49,** 403-408 (*August,* 1954).

Punched card computers originally developed for business accounting applications are now used to speed up the lengthy calculations involved in the detailed photometric analysis of asymmetric luminaires. Such an analysis performed by the new procedure was found to take one man-hour compared with 15 to 20 man-hours when ordinary desk-type calculating machines were used. P. P.

113. Modern ideas on nomenclature. 535.241

D. E. SPENCER. *Illum. Engng.,* **49,** 394-398 (*August,* 1954).

A system of concepts devised by Moon and the author is advocated in place of present illuminating engineering nomenclature. The concepts comprise "pharos," "pharosage" and "helios," which, with the addition of the adjectives "radiant," "luminous," etc., can be related to specific types of energy receptor (thermopiles, the eye, etc.). Arguments in favour of the system are given and criticisms are made of the present official nomenclature and of the proposed nomenclatures of G. A. Fry and D. M. Finch. P. P.

LIGHTING 628.93 628.971.6

114. Reflection properties of wet and dry road surfaces.

J. B. DE BOER AND A. OOSTRIJCK. *Philips Research Reports,* **9,** 209-224 (*June,* 1954).

Reflection properties of road surfaces are portrayed in the form of an "equivalent position diagram," which is a family of loci of a light source which moves at a fixed height over the surface so that $q.\cos^3 \gamma$ is constant, where q is the luminance factor and γ is the angle of incidence. A new method of experimentally determining the reflection properties is outlined, based upon this conception and applicable either for a sample in the laboratory or, with modifications, to field measurements. The data for bricks, cobblestones, asphalt and concrete are given both wet and dry. Some of the results show large discrepancies with those obtained by other experimenters, which are attributed to differences in the texture and wear of the samples measured. J. M. W.

628.971.6

115. Provision of contrast in street lighting.

O. REEB. *Lichttechnik,* **6,** 283-287 (*August,* 1954). *In German.*

A mathematical treatment of the problem of securing adequate contrast between a vertical object on the roadway and the background against which it is seen. The author takes a number of cases in which the conditions (mounting height and light distribution of the street lamps, reflection factor of road surface, position of object and of observer) correspond to practical conditions. He treats not only the case where both object and observer are stationary, but also a number of cases where either or both are moving, and he calculates the "critical" reflection factor of the object, i.e., that which causes it to merge into its background. The results are given in the form of a series of curves and the coverage of these can best be indicated by the following typical caption: "The critical reflection factor, when the observer is moving towards an object situated midway between two street lamps, shown in relation to the distance of the observer from the object." A diagram summarising a series of results shows the critical reflection factor when (a) object and observer are stationary, (b) when the observer moves towards a stationary object, (c) when the observer follows a moving object at twice its speed, (d) when he follows it at four times its speed. The author points out that it is quite erroneous to speak of definite "areas of concealment" in a lighted street. Uniformity of street surface brightness is desirable, but it may be sacrificed to some extent in order to obtain greater constancy of the critical reflection factor. J. W. T. W.

628.971

116. The application of floodlighting to buildings.

B. S. BENSON, JR. *Illum. Engng.,* **49,** 367-373 (*August,* 1954).

The first principles of floodlighting buildings are illustrated with photographs of models. Incorrect placing of the floodlights is shown to produce unpleasant shadow patterns or to result in uneconomical use of the available light. P. P.

628.972

117. Indoor foot-candles for maintaining plants.

R. L. ZAHOUR. *Illum. Engng.,* **49,** 383-386 (*August,* 1954).

Particulars are given of the artificial lighting necessary to maintain the growth of foliage plants for decorative purposes indoors. By careful choice of the level of illumination and duration of exposure, together with attention to certain horticultural details, it is possible to retard the growth of these plants to give a useful life of at least 12 months. P. P.

The Measurement of Temperature in Lighting Equipment

By H. F. STEPHENSON,* B.Sc. (Eng.), A.M.I.E.E., F.I.E.S.

Measurements of temperatures of lighting equipment are required on lamp caps, lampholders, leads, gaskets, glassware and plastic parts[1]. These measurements are difficult to make accurately and to repeat, and it is usual for faults in experimental procedure to result in low readings.

(1) Nature of Equipment to be Tested

Many items of lighting equipment are by their nature likely to vary in temperature between samples and on the same sample from time to time, and there is little point in quoting temperatures to closer than 2 deg. C. on a type test. Lighting equipment often contains a powerful source of heat, the heat being dissipated by radiation, by convection currents inside and outside the equipment, and by conduction from one part to another. Minor differences in thermal contact on assembly, small changes in orientation, slight external draughts and so forth may result in considerable temperature changes. So also can changes in manufacture of nominally identical components. It is, for example, important to make sure that exactly the same lampholder and filament orientation is used in tests which are to be compared.

Convection currents in still air can often be very localised, playing in a concentrated hot stream on whatever is above them. Minor changes may cause turbulence or deflect the stream.

Because small draughts may make temperatures unsteady and much lower than they are in still air, it is customary to test equipment in a double-walled enclosure with perforated walls, free from draughts. This will give the highest temperatures, but it is necessary to interpret the results realistically. If the equipment is likely to be subjected to still air conditions only rarely, and if the effects of high temperature in the equipment are slow and cumulative, temperatures measured in still air conditions may be unreasonably restrictive. Similarly, it is usual to measure the temperature *rise* of the equipment above a measured ambient temperature; the resulting temperature for any ambient within the normal range of ambients can then be found. It has sometimes been the practice to calculate temperatures for a high ambient temperature as specified for other electrical equipment, such as motors, cables or switchgear; this may be quite unrealistic for lighting equipment installed in interiors which people use, in which the ambient is limited by considerations of comfort. Where a limitation of absolute temperature exists, based, for example, on the highest temperature which a component can withstand, there are advantages in giving the result in terms of the highest ambient temperature in which the equipment should be used for long periods while alight without exceeding the specified limit for the component.

* Research Laboratories of The General Electric Company, Limited, Wembley, England.

(2) Test Equipment

(2.1) *Enclosure.*

A suitable test enclosure is specified in B.S. 889[2]. It may be conveniently made of perforated sheet metal, the two walls being separated by about 15 cm. The photograph Fig. 1 shows a test equipment with two enclosures, so that two tests may be made at once. An external test point is provided for equipment too large to be tested in the enclosures.

(2.2) *Temperature Measuring Means.*

The most convenient means of measurement is the thermocouple, which is suitable for attachment to small and inaccessible parts and convenient for remote electrical measurement. Other methods which are sometimes useful employ resistance thermometers, which can be wound round such objects as tubular fluorescent lamps[3], temperature-indicating paints or crayons and occasionally thermistors, as indicated below.

Any temperature-measuring device measures only its own temperature; the important part of the technique is to ensure that it reaches the temperature of the part to be measured without disturbing the temperature of that part by its presence. There is no great difficulty in doing this when measuring the temperature of a massive body of large heat capacity and good thermal conductivity. With thin material, and especially with material of poor conductivity, it is quite difficult to bring the sensitive element into good thermal contact with the body to be measured and to ensure that the thermocouple does not vary the temperature of the specimen by conducting heat away from it or bringing to it heat which the thermocouple has acquired from a neighbouring convection stream. The temperature of the couple may be raised above that of the specimen by radiation traversing a

Fig. 1. Test equipment with two enclosures.

transparent specimen. These errors are reduced to negligible amount by using thin polished metal thermocouple wires and by keeping the wires in contact with the specimen for at least 2½ cm. on either side of the junction. They may be attached by cement, and it is essential to use only the minimum amount necessary to fix the couple. Preferably the cement should be applied to the sides of the wires at the junction and not allowed to cover the outer surface, which would be equivalent to lagging the couple. For most surfaces "Durofix" is satisfactory up to about 100 deg. C., and "Araldite" Type 1 rods for higher temperatures (up to about 300 deg. C.). For "Perspex" any of the "Tensol" cements may be used. Alternatively the couples may be held in contact with the surface by tension, and for these cases it is essential to use a little "Vaseline" or oil to improve the thermal contact.

For temperature measurements on convex surfaces the strip couples are held under tension in a spring holder and pressed against the surface. For flat surfaces another holder is used, which, when resting in the surface, allows a bowed strip couple on it to lie flat along the surface.

(2.3) *Thermocouples*

Base metal thermocouples are used because they are cheap and give the highest thermal E.M.F.s (40-60 μV/C deg.). The materials should be uniform in properties along their length, i.e., free from impurities, and the combination should preferably give a closely linear relation between E.M.F. and temperature over the temperature range used. The materials should have a low thermal conductivity, be bright and polished to avoid radiation effects and, for use with millivoltmeters, have a low resistance temperature coefficient.

(2.3.1) *Iron-Constantan (Eureka)*

This combination is suitable; it gives the highest E.M.F. of any (55-60 μV/C deg.). The iron, however, is difficult to obtain pure, it is not bright and may rust. Also its thermoelectric properties may be unstable[4].

(2.3.2) *Copper-Constantan*

These give a slightly lower E.M.F. (45 μV/C deg.). The materials are stable but are not recommended because of the high thermal conductivity of copper and its high temperature coefficient.

(2.3.3) *"Ferry"—"Brightray C"*

These materials are stable and manufactured to a rigid specification; they may be produced bright and polished and do not tarnish readily at the usual temperatures. The E.M.F. is of the same order as Copper-Constantan, but the E.M.F.-temperature relation is not quite as linear. The thermal conductivity and temperature coefficients are low.

Experiments have shown that round wires of 37 s.w.g. (0.1727 mm. diameter) and strips of 0.005 in. x 0.025 in. (0.127 x 0.635 mm.) cause negligible errors if the above precautions are taken.* If the wire and strip are produced from the same batch of material, the same calibration is obtained (to well within the accuracy needed for this class of work) for both types of couple when used on a potentiometric circuit.

The wires can be made up as a flat twin pair insulated with glass silk†, which is a very convenient arrangement.

The junctions are made by electric arc welding under coal gas. Strip couples may be formed by resistance butt welding, the strips being aligned in a special holder. The flash must be removed to leave a smooth surface

* The wires and strips are obtained from Henry Wiggin and Co., Ltd., Wiggin Street, Birmingham, 16, and should be ordered as "bright annealed" material.

† By the Saxonia Electric Wire Co., Roan Works, Greenwich, S.E.10.

to the junction. Details of these techniques have been given by V. M. Hickson[5].

(2.4) *Circuit.*

The thermal E.M.F. is best measured by a potentiometric method, which eliminates errors due to couple resistance. Suitable thermocouple potentiometers are available from most instrument makers. Alternatively, a convenient basic circuit is indicated in Fig. 2, which also gives the complete circuit for the apparatus illustrated in Fig. 1 which has two testing enclosures and one external test point for equipment too large to get into the enclosures. It will be seen that a potential divider is used to provide the opposing E.M.F. A voltmeter reads the E.M.F. applied to the potential divider from a potentiometer energised by a dry battery. The potential divider is tapped to give a series of ranges so arranged that it is not necessary to read the voltmeter at less than about half of full scale deflection.

In order to handle the output of a series of couples, the circuit in thermocouple materials is led to a uniform-temperature terminal box in each enclosure, to which both the couple leads and the cold-junction leads are brought. Thereafter the circuit is continued in copper throughout. Provided that all the terminals in the box are at the same temperature, any thermal E.M.F.s generated there will cancel. The box is made in metal with double walls forming a double radiation screen. All switches are in copper throughout.

(2.5) *Cold Junction and Ambient Temperatures.*

It is found most satisfactory in practice to measure separately the cold-junction ambient temperatures, though methods have been proposed of maintaining the cold junction at the ambient temperature or of immersing it in ice, which for this class of work is unnecessary and inconvenient. The cold junction is kept in paraffin in a small, deep Dewar vessel and its temperature measured by a mercury-in-glass thermometer, the couple being wrapped round the bulb of the thermometer. The ambient temperature is measured by a mercury-in-glass thermometer within the test enclosure, the bulb of which is screened by a double cylinder of polished aluminium open top and bottom, which forms a radiation screen. A suitable size is about 8 cm. diameter and 10 cm. long, the two walls being about 1 cm. apart. Thermocouples are conveniently calibrated at the steam point by a hypsometer of commercial type, corrected for barometer reading in the usual way. At higher temperatures checks are made by the freezing points of tin and lead. Useful information is given in B.S. Code 1041[6].

All thermometers are checked against a standardised thermometer.

(2.6) *Control of Lamps Under Test.*

Panels are provided for the maintenance of the lamp under test at the correct wattage by the usual techniques, using a dynamometer wattmeter. Tests may be made using either the rated mean wattage of the lamp, or the upper limit of tolerance on watts for the type of lamp, or with a suitable overload, as may be appropriate.

(2.7) *Other Methods of Measuring Temperature.*

(2.7.1) *Millivoltmeter.*

Instead of the potentiometer circuit a millivoltmeter may be used, but it is less satisfactory. The instrument

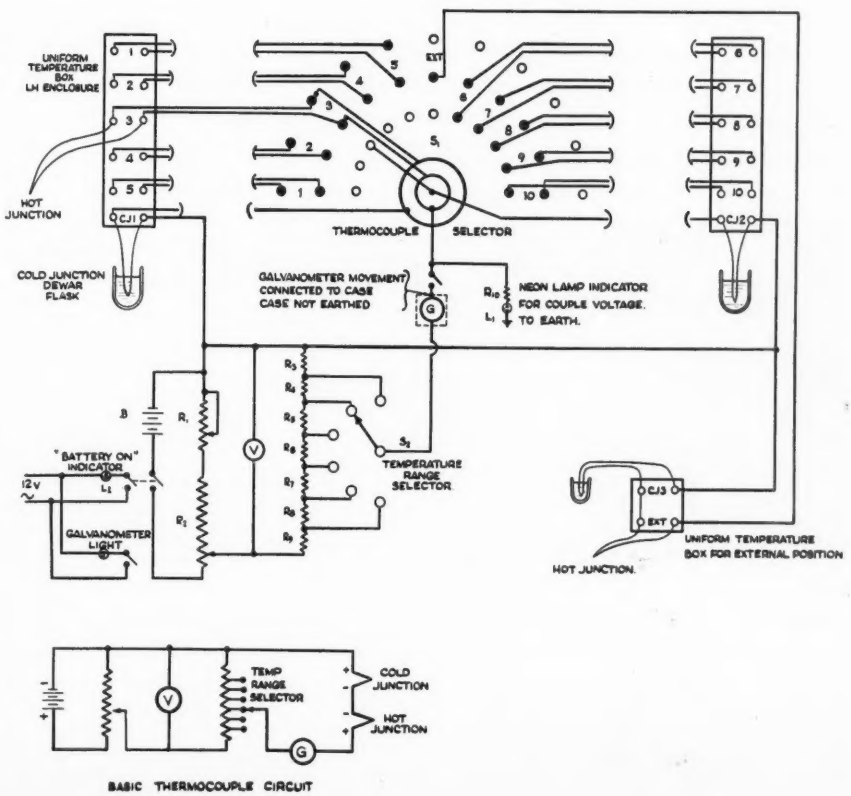


Fig. 2. Temperature measuring circuit for two enclosures and one external position.

R_1 30Ω ⎫ *Colvern CLR 7001/257*
R_2 300Ω ⎭ *concentric spindles*
R_3 10.00Ω *Tinsley LS2 coils*
R_4 15.00Ω ,, ,, ,,
R_5 13.64Ω ,, ,, ,,
R_6 38.64Ω ,, ,, ,,
R_7 22.73Ω ,, ,, ,,
R_8 100.0Ω ,, ,, ,,
R_9 24151Ω ,, ,, ,,
R_{10} 47,000Ω *1-watt carbon*
L_1 *LN1 Osram neon indicator*
L_2 *12-volt 6-watt S.B.C.*
S_1 *Tinsley Type 2623C/228 stud switch*
S_2 *Tinsley Type 2623C/56 stud switch*
G *Tinsley Type 4360A/45 5Ω 2 secs. galvanometer*
V *Sub-standard moving coil voltmeter 3-volt F.S.D.*
B *4½-volt dry battery G.E.C. type BA6110*

itself forms the cold junction, the temperature of which is not always certain; its readings are affected by the resistance of the couple in use. It is important to choose the couple resistance and meter carefully so that when used together the sensitivity is sufficient and the meter is not overdamped. The combination of millivoltmeter and couple should be calibrated as a unit. For exploring a piece of equipment to find the position of maximum temperature such a device has advantages sometimes.

(2.7.2) *Temperature Indicating Paints.*

Temperature indicating paints and crayons are useful for exploratory work.*

(2.7.3) *Thermistor.*

Thermistors may be used for temperature explorations and temperature measuring instruments are marketed using them as the sensing element. They have, however, been found unreliable for absolute measurements on lighting equipment, for it is very difficult to bring the thermistor element to the temperature of the specimen and to avoid disturbing the specimen temperature.

(2.7.4) *Glass Thermometers.*

Glass thermometers are quite unsuitable for measuring the temperatures of parts of lighting equipment; they can, however, be used for measurements of ambient temperature within a fitting but may need a radiation shield around the bulb.

* Convenient types are made by J. M. Steel, Kern House, Kingsway, London, W.C.1.

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(2) B.S. 889: 1947. Flameproof Electric Lighting Fittings.
(3) Winch, G. T., Photometry and Colorimetry of Fluorescent and other Electric Discharge Lamps, Trans. Illum. Eng. Soc. (London), **11,** 131 (1946).
(4) Roeser & Dahl, Bureau of Standards J. of Res., **20,** 337 (1938).
(5) Hickson, V. M., The Welding of Thermocouples, J. Sci. Insts., **17,** 182 (1940).
(6) B.S. Code 1041: 1943. Code for Temperature Measurement.

400-watt Mercury Fluorescent Lamp

When lighting with high-pressure mercury lamps was introduced the greenish colour of the light tended to restrict its use for some applications, particularly interiors. This led to the development of mercury fluorescent lamps, in which a powder coating on the bulb is activated by the discharge, giving a better colour and a higher efficiency.

As in the development of low-pressure mercury fluorescent tubes, one of the objectives in attaining an acceptable colour has been to increase the proportion of red in the spectrum of the light emitted. In the mercury discharge itself the red ratio is only about 1 per cent. The first mercury fluorescent lamps increased this figure to between 4 and 5 per cent. Further experiments with improved fluorescent powders later enabled a ratio of 7 per cent. to be obtained, and although this increase sounds small numerically the visual improvement is very marked.

"Osram" 400-watt MBF/U lamp.

The 80 and 125-watt lamps with these improved powders were introduced in September, 1953. The range has now been extended to include a 400-watt lamp with similar colour properties. The advantages of colour correction are therefore now available in a size of lamp which is widely used for interior and exterior lighting. This development has been made possible by using a germanium-based phosphor which remains efficient at the relatively high temperatures involved. A further advantage is that the new powders have a white "body" colour which does not distort the luminous radiation from the discharge—one of the disadvantages of earlier designs of lamp.

The efficiency of the new lamp is higher than the plain mercury lamp—42 lumens per watt as compared with 34 lumens per watt—and it can be burned in any position without requiring a magnetic deflector. The short quartz inner inside which the discharge takes place confines the arc sufficiently to restrict the bowing upwards which occurs when such lamps are burned horizontally.

The new lamp is likely to find application in industrial interior lighting and will permit an increase of luminous efficiency compared with installations at present using a combination of mercury and tungsten lamps in order to provide an acceptable colour. Space floodlighting outdoors is another sphere for the lamp, particularly in areas such as garage forecourts and car parks. In street-lighting the lamp may recommend itself in some cases as an alternative to fluorescent lanterns. The lamp has a nominal average life of 4,000 hours. These lamps are marketed by the G.E.C. Ltd., B.T.H. Co. Ltd., Philips Electrical Ltd., and Siemens. List price is £9.

The Testing of Miners' Lamp Bulbs

A description of the testing procedure and equipment at the National Coal Board testing station at Treorchy.

By G. OWEN RICHARDS,*
B.Sc., Ph.D., F.R.I.C.

The National Coal Board have recently set up a testing station at Treorchy, South Wales, for the routine testing, on a national basis, of a selected portion of the 2,500,000 miners' lamp bulbs purchased annually. The objects of the station include some measure of quality control, but are also concerned with the accumulation of basic information regarding the varied types of miners' lamp bulbs supplied by the several manufacturers.

The large proportion of these bulbs is manufactured in accordance with the specification set out in B.S. 535: 1953, and it is upon this specification that the apparatus and procedure have been based. The routine tests are divided into three types—physical, photometric, and life tests.

Physical Tests

The first of these is concerned with physical dimensions, and with the strength of the bond between the glass envelope and the cap. The determination of light centre length (the distance between the geometric centre of the filament and the tip of the soldered pip) is included in these tests, and because of its important effect upon light distribution from the cap-lamp reflector, accurate measurements are made by projecting a magnified image of the bulb on to a calibrated ground-glass screen. The bulb manufacturer here has to work to fairly close tolerances, the maximum permitted variation being plus or minus $1\frac{1}{2}$ mm.

Photometric Tests

The specification requires the bulbs to pass an initial rating test in regard to current and lumen output at the rated voltage. The photometric apparatus used for this purpose is novel in design, and for this reason a somewhat detailed description may be of interest. The equipment takes the form of a console (Figs. 1 and 2), which was designed and constructed by the Electronics Division of Murphy Radio, Ltd., in conjunction with National Coal Board staff. The console houses a power-operated turn-

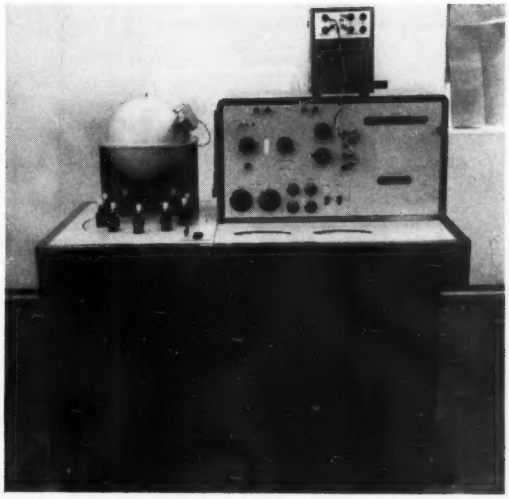
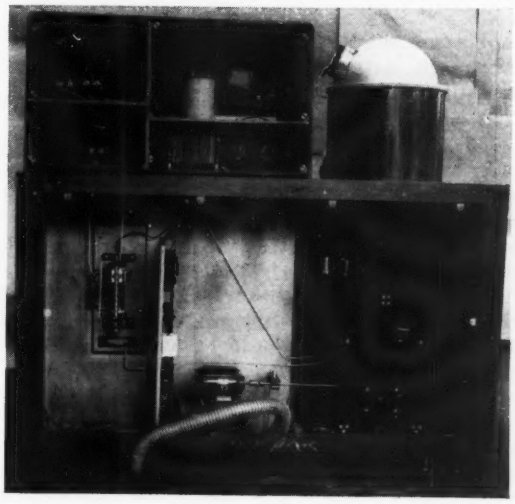


Fig. 1. The console. Fig. 2 (below). Rear of the console.



* National Coal Board.

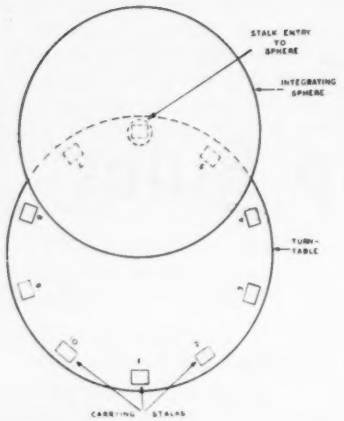


Fig. 3 (above). Position of turn-table relative to integrating sphere.

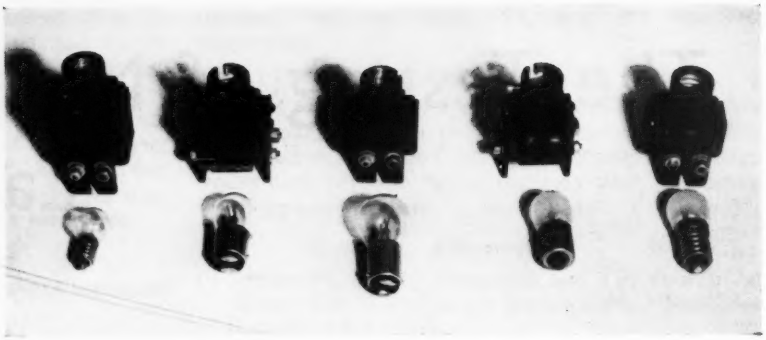


Fig. 4 (above, right). Range of lamp-holders.

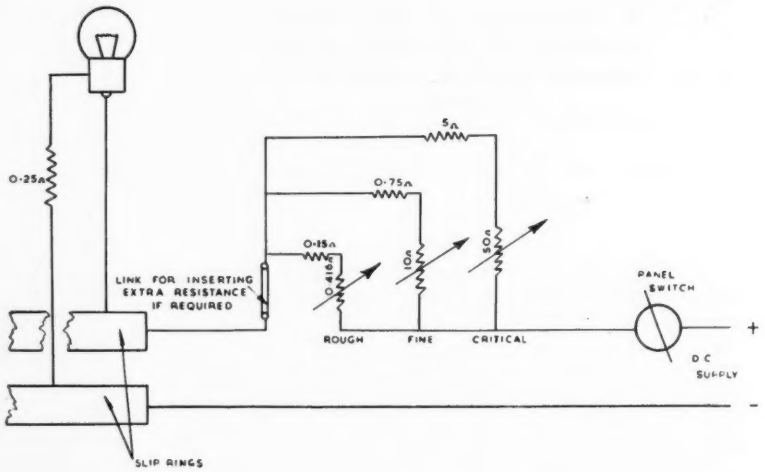


Fig. 5. Voltage supply circuit.

table (Fig. 3) accommodating 10 stalks, each carrying a bulb-holder (Fig. 4). The holders are of several designs, but all are constructed to ensure that the light centre of each bulb is centred in the sphere during test. The test bulbs are supplied from a "NIFE" (Type D.N.7) battery which is permanently connected to a Davenset battery charger. The turntable is rotated by an electric motor actuated by a foot-switch with automatic take-over and stop circuits. Each bulb in turn is thus brought under the vertical axis of the integrating sphere and by press-button control is raised into the sphere for lumen measurement, its correct positioning being indicated by a neon pilot light. The applied voltage is adjusted and current and lumen readings are made.

Voltage is fed through a panel switch and resistor network (Fig. 5) and is supplied to the turntable through silver carbon brushes and silver-plated slip-rings. From the latter each bulb receives its supply through individual leads, each negative lead having a 0.25 ohm resistor mounted in series. This is used for current readings, the voltage drop across the resistor being carried to a voltage and current metering box mounted beneath the turn-table (Fig. 6). This box also receives two leads from the bulb-holder for voltage metering, the circuit being as shown in Fig. 7. The current metering circuit is shown in Fig. 8.

During rotation, as each stalk arrives at its measuring station, the four projections from the metering box engage with stationary contacts in a voltage and current pick-up

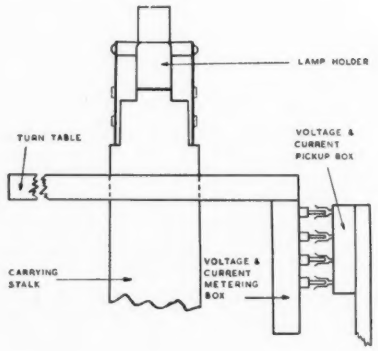


Fig. 6. Arrangement for voltage and current metering.

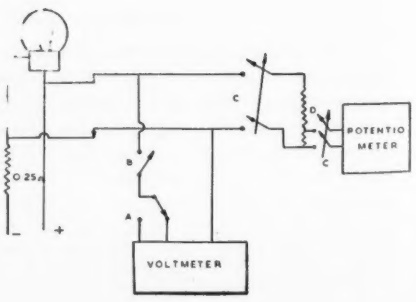


Fig. 7. Voltage metering circuit.

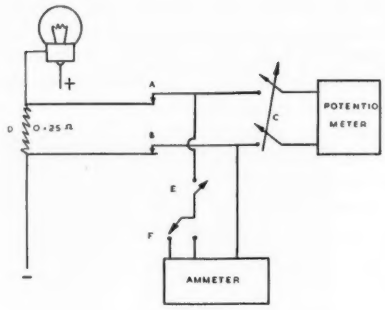


Fig. 8. Current metering circuit.

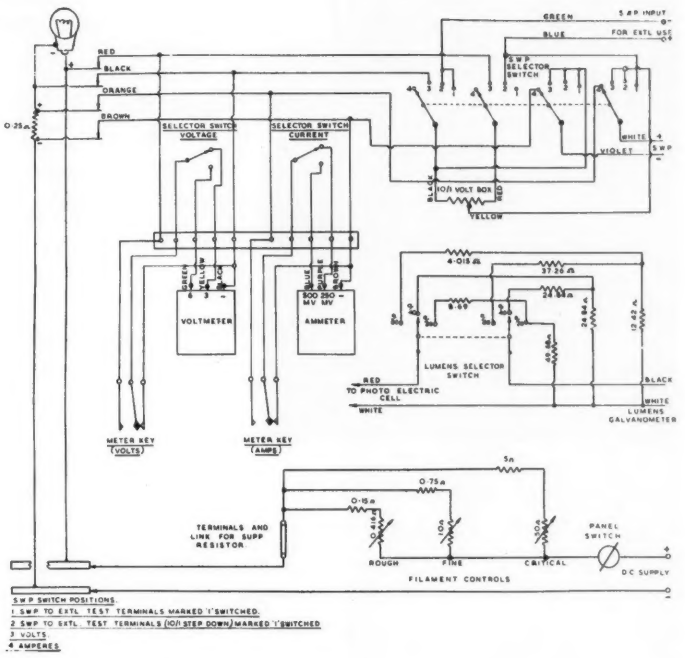


Fig. 9. Main circuits of console.

box from which connection is made to a sub-standard voltmeter (Turner, moving coil, 1,000 ohms/volt, Ranges 0-3 and 0-6 volts), and ammeter (Turner, moving coil, 1,000 ohms/volt, Ranges 0-250 and 0-500 millivolts scaled 0-1 amp, 0-2 amps). Facility to check the continued accuracy of these meters is provided by a built-in Tinsley slide-wire potentiometer.

The light output of the test bulb is integrated by a 12-in. diameter sphere, on the side of the upper portion of which is mounted a photo-electric cell as seen in Figs. 1 and 2. Inside, a 1½-in. diameter diffusing screen is fixed 4 in. from the photo-cell and parallel to its surface. The latter is traversed by a double-vee shutter which is operated by a micro-screw adjustment providing a means of regulating the amount of light falling upon the sensitive surface. All internal surfaces of the sphere are coated with standard white matt paint. The voltage produced in the photo-cell is fed through a resistor network and selector switch to the Tinsley (Type S.S. 5.45) Galvanometer, the selector furnishing three ranges of lumen readings, 0-20, 0-40, and 0-80, arranged to ensure that the photo-cell is always working into the same value of load, approximately 14 ohms.

The slide-wire potentiometer is set in the face of the panel, and a selector switch enables two individual inputs to the potentiometer to be brought independently into circuit. Position 1 is fed through a further selector switch allowing the following measurements to be made: external values from 0-1.9 volts; external values from 0-19 volts; internal voltage on the holder of the bulb under test; the voltage across the current resistor in series with the supply to this bulb.

The B.S. 535 stipulates that all bulbs under test shall be allowed a soaking period of 10 minutes prior to measurement of lumen output in order to ensure that thermal equilibrium has been established. It is a further condition that readings shall then be taken without interruption of the current. In the design of the apparatus, particular attention was paid to these considerations, and in operation each bulb is burning during nine test periods preceding the measurement of its lumen output. Consequently, the specified conditions are faithfully fulfilled, and in addition the design promotes rapid photometric measurement—an essential factor for a station of the type under review. The method employed is one of substitution photometry. Standard bulbs, of the various categories calibrated by the National Physical Laboratory, are used to set up the instrument for the appropriate test conditions, and working sub-standards are used throughout all routine tests. Coupled with the ready facility for checking the voltmeter and ammeter potentiometrically, this procedure gives continual and frequent assurance that the standard of accuracy is maintained.

The complete wiring diagram of the console is shown in Fig. 9.

Life Tests

After passing the initial rating tests, bulbs are burned for 40 per cent. of the specified life on a strictly regulated and continuously recorded A.C. voltage. Measurements

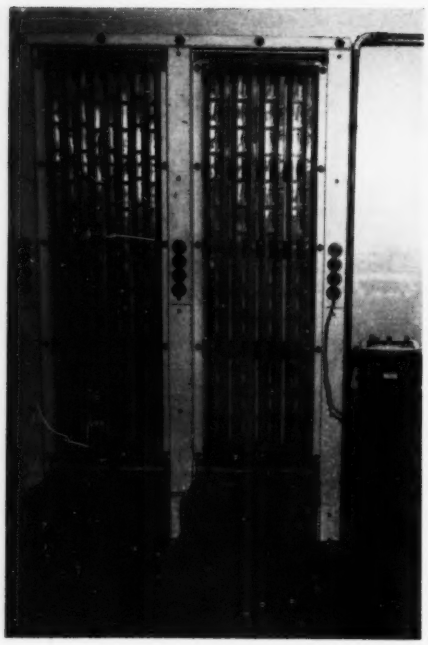


Fig. 10. *Life test racks.*

are then made of lumen output and current, and burning of the bulbs is continued until 60 per cent. of the life has elapsed. Measurements of lumen output and current are again made, and thereafter the bulbs are replaced in the life-test racks and burned to destruction.

The life-test racks, the general design of which can be seen in Fig. 10, are constructed of stout copper bars carrying screwed-on bulb-holders of special design having phosphor-bronze spring contacts. The 230-volt A.C. mains input is fed through a constant voltage transformer (Foster Type F.C.) and thence through an electronic voltage controller (Foster Type 12A.38) having an output of 230 volts ± 0.5 per cent. on full load. The former is able to correct variations in voltage and furnish a steady output when the frequency of the supply remains constant. It is not adequate, however, to work within the required limits when frequency changes occur. Conversely, the voltage controller output is unaffected by frequency variation, and although giving a mean output within the requirements, momentary fluctuations fall outside the limits. In cascade, the two units give a voltage supply which is well within the specified tolerances. This supply is taken to separate step-down transformers (Zenith Double-wound, self-cooled) via direct switching contactors and series potentiometers (Fox, Toroidal type PX/100/PP). The recording voltmeter (Elliot Moving Iron, Type "204") is wired in parallel with the individual test rack circuits. The

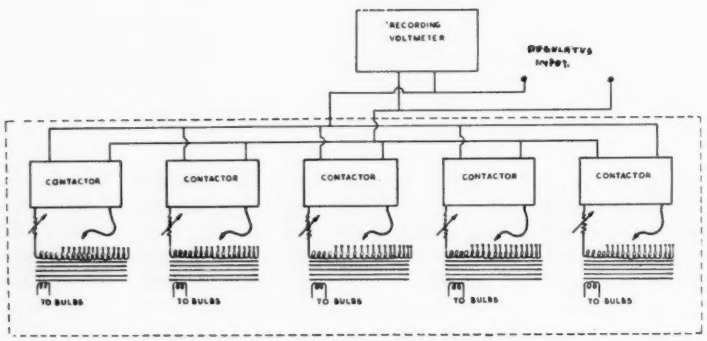


Fig. 11. *Life test circuit.*

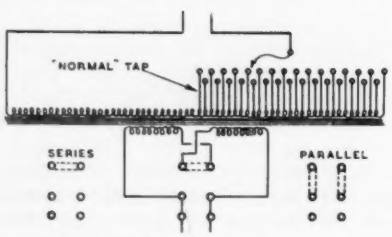


Fig. 12. *Transformer circuit.*

With the secondary connected in series and the input connected to the "normal" tapping the output would be 6 volts and could be reduced in 30 steps of 0.1 volts down to 3 volts by means of the tappings on the over-wound primary. Secondary current is 60 amps. at any tapping.

With the secondary connected in parallel the normal output would be 3 volts reduced in 30 steps of 0.05 volts down to 1.5 volts. Secondary current is 120 amps. at any tapping.

secondary voltage from each individual step-down transformer is fed diagonally to the set of busbars comprising the life-test rack.

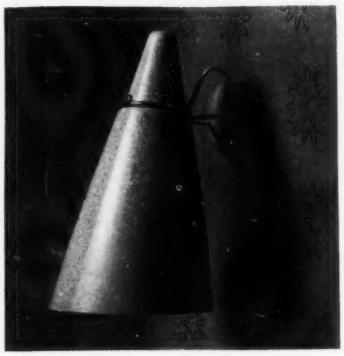
Metering leads are attached to each pair of busbars, and are brought to four metering points at the front of the panel. The voltage on any pair of busbars is read on a portable voltmeter (Sangamo-Weston, sub-standard Dynamometer, Model S.68) and critical adjustments made by the toroidal potentiometer. The circuits for the life-test racks are indicated in Fig. 11, and that for the step-down transformer in Fig. 12.

It is interesting to note that the nominal life of a bulb, for which it undergoes test, is exceeded by between two and three times this amount in pit use. Under these conditions, of course, it operates on D.C., and because it is battery supplied is probably under-run for a considerable portion of its useful life.

The station maintains contact with the Safety-in-Mines Research Establishment, which has been carrying out work of a similar nature for a considerable time, and also with the manufacturers of miners' lamp bulbs.

LUMINAIRES

No. 7



Spun aluminium shade enamelled in a range of eight colours. Polished beech-wood fixing plaque.

Price, £2 9s. 6d.

Pleated acetate shade removable for cleaning. Polished beech-wood fixing plaque.

Price, £1 17s. 3d.

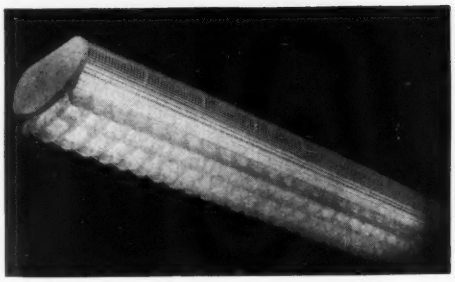
Spun aluminium shades enamelled in a range of eight different colours. Shades may be inverted. Also available as five branch.

Price, £6 7s. 6d.

Pleated acetate shades which may be removed for cleaning. Available in three colours, white, ivory or apricot. Shades may be inverted. Warm brass caps and ceiling rose. Also available as three branch.

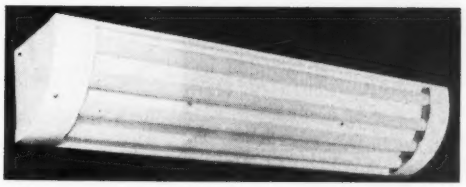
Price, £8 8s.

CONE FITTINGS, LTD.



Decorative fluorescent unit produced from a clear plastic material by the injection moulding principle. The engraved diffuser, whilst reducing glare to a minimum, does not sacrifice light output to any degree.

Prices (incl. gear) : 2 ft. Twin, £10 4s. 6d. (P.T. 18s. 9d.)
4 ft. Twin, £14 7s. 0d. (P.T. £1 10s. 0d.)
5 ft. Twin, £18 15s. 0d. (P.T. £2 1s. 3d.)
5 ft. Triple, £22 2s. 6d. (P.T. £2 1s. 3d.)



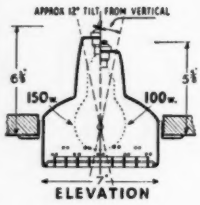
Shop window luminaire in which the end plates or flicker shields can be removed by a forward movement for relamping. This also enables the installation to be arranged as a continuous line without space in between luminaires. Available for use with two, three or four 4 ft. or 5 ft. fluorescent lamps.

Price : Four Lamp 4 ft., £17 10s.
Four Lamp 5 ft., £22 10s.

H. W. FIELD & SON, LTD.

A 1000-watt mercury high-bay industrial lighting unit for use in steel works, heavy engineering shops and in similar lofty industrial interiors. The unit, which embodies heat-resisting glass reflectors, has been designed to suit the characteristics of the new 1000-watt MB/V mercury discharge lamp and provides a broad intensive light distribution. It has a cast aluminium top canopy and steel cover in which the reflector is sealed. Four stout metal straps forming part of the fitting assembly allow for supplementary strap suspension from the roof structure and for the provision of stirrup mounting where necessary.

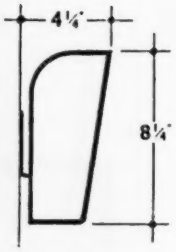
HOLOPHANE, LTD.



A semi-recessed window lighting unit for use with either 100 or 150-watt B.C. pearl lamp. Manufactured in super purity anodised aluminium. It is adjustable and pattern-pierced to provide decorative relief with anular slot to allow ventilation. Requires 7¼-in. diameter cut-out for fixing. Supplied complete with soffit ring, fixing screws and holder.

Price, £2 15s.; Louvre, 10s. 6d. extra.

COURTNEY POPE (ELECTRICAL), LTD.



Wall bracket using 60-watt lamp. Metalwork is finished in white. Glass is frosted with clear and applied with white lines—other glasses are available.

Price, £3 2s. (P.T. 11s. 8d.)

TROUGHTON & YOUNG (LIGHTING), LTD.

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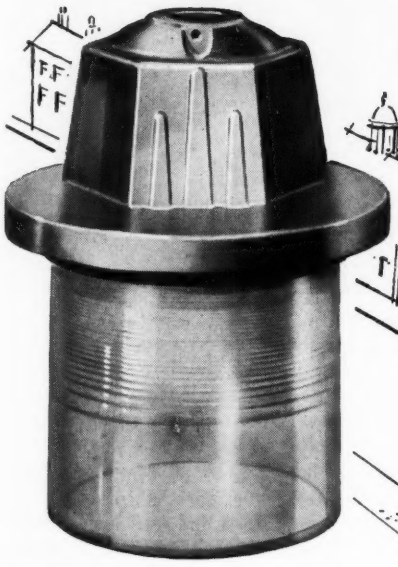

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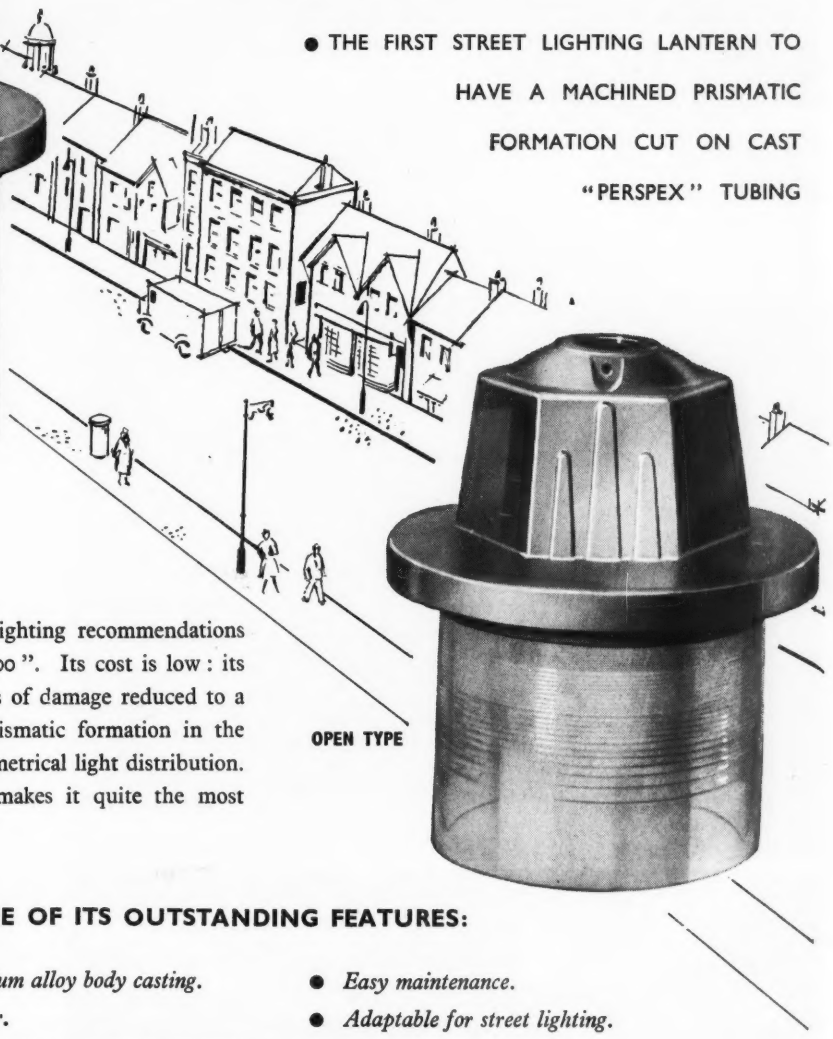

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- *Low initial cost.*
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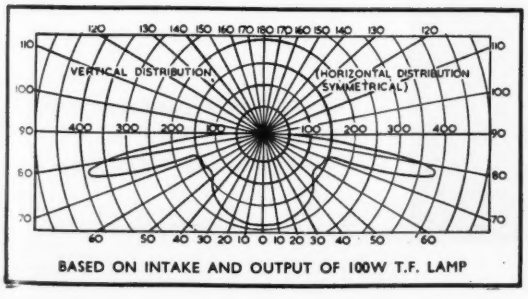

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Lighting in the S.S. Iberia

The new P. and O. liner *Iberia*, sister ship of the *Arcadia*, sailed on her maiden voyage on September 28. Lighting for the principal passenger spaces has been provided by The General Electric Co., Ltd., and the extensive hot cathode cornice installations in the public rooms are equipped throughout with the recently introduced "Deluxe Warm White" lamps. This is the largest installation yet made of these lamps in a passenger ship, totalling about 1,000 of the 2-ft., 20-watt, and 4-ft., 40-watt sizes. The "Deluxe Warm White" lamp was specially developed for social lighting purposes and the satisfactory blend achieved with tungsten lighting makes it particularly suitable for marine installations where fluorescent lighting has to be combined with lighting from decorative tungsten fittings in the same space, or where the two types of lighting are in proximity and it is desirable to avoid a noticeable contrast when passing from one area to the other. This lamp also represents the latest stage in the de-

Top: *First-class observation lounge.*

Centre: *First-class writing-room.*

Bottom: *Tourist lounge.*

velopment of a fluorescent light source giving a generally acceptable rendering of the colours of furnishings and foodstuffs and of the complexion.

Cold cathode lighting with double rows of "Ivory" and "Gold" tubes is installed in the first-class drawing-room, first-class library, first-class dance space and tourist dance space. Dimming equipment has also been supplied for the first-class dance space lighting.

Some 25 special designs of decorative tungsten lighting fittings were prepared by the G.E.C. in conjunction with the architects, McInnes, Gardner and Partners. Contemporary styling has been introduced in some items, such as wall brackets for the first-class dining-room and pillar-mounted fittings in the first-class dance space, and in floor standards. Two handsome wall lanterns of traditional design with light bronze metalwork have been supplied for flanking the bar in the first-class observation lounge. A canopy incorporating circular luminaires projects over the bar counter.

In addition to the cornice fluorescent installations, some hot cathode lamps are installed in decorative fittings, such as a large 5-ft.-square fitting with luminating glass side panels in the first-class veranda café and various designs with glass or "Perspex" enclosures in the shop and hairdressing saloon.

Top: *Tourist dining-room.*

Centre: *First-class dining-room.*

Bottom: *Veranda café.*

Kidbrooke School

Typical 480 sq. ft. classroom.

A chemistry laboratory.

Kidbrooke School, a London County Council comprehensive secondary school for girls, opened in September, 1954. The new buildings include an assembly hall to seat nearly 1,500, a library, reading rooms, five gymnasia, laboratories, studios, housecraft flats and practical rooms for needlework, craft, cookery and commercial subjects, in addition to classrooms, some of which are equipped as subject rooms. The school occupies a site of nearly 10 acres. Work on the school began in April, 1951; the building costs are estimated to be about £731,000.

Most of the teaching area is in three three-storey blocks. Two of these are in line parallel with the northern boundary of the site, while the third, more to the south, is linked to them centrally by a "bridge" which contains the library and staff rooms. In each block there is a comprehensive range of ordinary and practical classrooms, together with lavatories and cloakrooms. This distribution is intended to avoid unnecessary movement of children at lesson-changing time.

A large modern kitchen is placed centrally in the northern long block, and it will provide meals which will be taken in near-by rooms situated on three floors. These rooms will also be used, as far as possible, for teaching and other purposes.

At the eastern end of the site, near the principal entrance, a spacious main foyer opens into a large assembly hall which is unique in that it has a shell concrete roof, one of the few in Europe, which needs no supporting pillars and ensures a clear view of the stage from all parts.

There are four typical sizes of classroom, 480 sq. ft., 560 sq. ft., 640 sq. ft. and 860 sq. ft. in area. Reflection

factors of the main surfaces within the rooms are, ceilings 80 per cent., walls 20/55 per cent. and floors 40 per cent. The lighting is designed to give a minimum of 10 lm/ft². Because of the low ceiling height use is made of a large number of low brightness lighting points. The luminaires used are a simple conical ceiling mounted glass shade incorporating a white metal ring louvre. These luminaires have a brightness of less than 1,000 ft.-lamberts and give a cut-off of 45 deg. when used with a 75-watt pearl lamp. They are comparatively small and inconspicuous.

The two smaller types of classroom also have 5-ft. 80-watt fluorescent chalkboard units. These are not used in the large classrooms which are used as practical instruction rooms or also as dining rooms.

In the laboratories, housecraft, needlework and practical rooms an illumination of 15 lm/ft² was required and in these rooms fluorescent lighting has been used. Single lamp 5-ft. 80-watt units are mounted direct on the ceiling and parallel with the windows, i.e., in the same line of vision as when looking at the chalkboard, but louvres are fitted to effectively cut off any direct view of the lamps, thus preventing glare.

In the library ceiling mounted spheres each housing a 150-watt tungsten lamp are used. The gymnasia are lighted by means of 300-watt R.L.M. luminaires fitted with diffusers and wire guards. Tungsten lighting is also used in the kitchens. Continuous trough fluorescent luminaires are used in the arts and crafts rooms so located as to simulate natural daylight as regards direction.

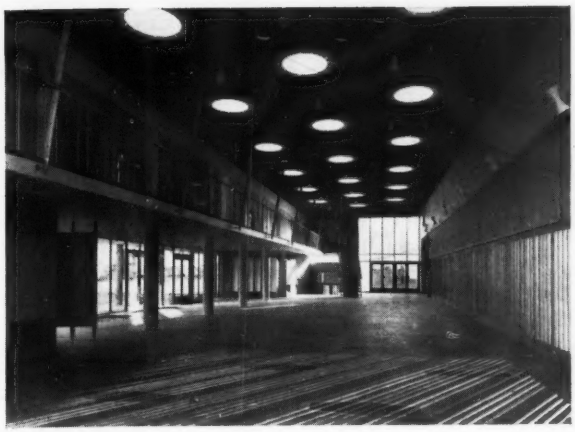
The hall is lighted by a combination of direct and indirect lighting. The direct component is provided by 32 300-watt ring louvred luminaires giving a cut-off at approximately 45 deg. They are recessed into the ceiling in order to be as inconspicuous as possible and also to fit into the ceiling pattern. Such an arrangement alone would have meant that the ceiling would be dark; this is avoided by the use of indirect lighting from 25-watt tungsten lamps concealed in a cove below the east and west windows and from brackets on the south wall, and from 25-watt tungsten lamps at 1-ft. centres, concealed in each of the nine " lifts " of the main ceiling.

The lighting in the hall can be dimmed either in sections or altogether. The load is about 34 kw. divided into four main groups—auditorium ceiling with four dimmer plates, auditorium side galleries with two plates, auditorium coves with nine plates, and concert platform with nine plates. Each circuit is provided with a miniature circuit breaker, dimmer fuses and neutral links; all gear, including magnetic clutches, full-up contactors and control relays is incorporated in one framework.

The foyer of the hall has two ceiling levels, 18 ft. and 8 ft. 6 in. On the higher ceiling are mounted luminaires similar to those used in the classrooms and in the lower ceiling semi-recessed units are used.

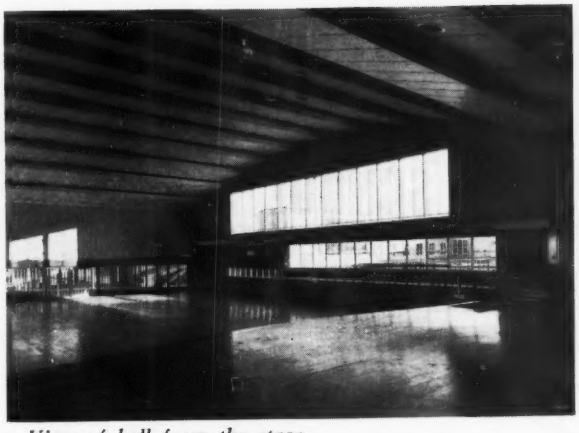
The stage lighting schemes had to meet certain special requirements brought about by the fact that the stage is used for many purposes apart from the production of stage plays. These needs precluded the adoption of normal methods of suspension and wiring, as the whole of the lighting equipment, curtains, curtain tracks, etc., had to be completely portable and capable of being removed in a comparatively short time in order that the stage can be left clear of obstruction.

All lighting equipment, curtains, etc., are therefore carried on a Hall steel frame stage fit-up approximately



The foyer.

Hall looking towards stage.



View of hall from the stage.

36 ft. wide and 18 ft. deep. This fit-up can be easily dismantled and stored under the stage; the lighting equipment therefore had to be readily removable for storage and as easily erected and connected for a stage performance.

The actual stage lighting scheme is fairly simple and consists of 500-watt mirror spots mounted on standard aluminium alloy brackets, on the side wall of the auditorium for lighting the apron stage, a No. 1 batten comprising a 32-ft. length of gas barrel internally wired for six 500-watt floodlights and six separate spotlights, a No. 2 batten consisting of four 6-ft. lengths of three-colour magazine batten. In addition there are stage dip plugs for portable equipment on stage level and fly plugs for extra overhead units. All the lanterns on the front batten can readily be unplugged and removed from the barrel, which can then be taken off its suspension lines and stored. Similarly No. 2 batten can easily be removed section by section from its barrel.

No plug boxes or connector boxes were permitted on the side walls of the stage, and therefore some other method of electrical wiring had to be devised. The stage lighting is controlled by an 18-way Strand Electric dead front mechanically interlocking switchboard, fed from a single-phase A.C. supply, which is located in a room offstage from which the stage electrician has a full view of the stage. The circuit wiring for the stage circuits is taken to multiway plug boxes situated under the stage floor in positions corresponding to the location of the fit-up legs. The overhead battens are fitted with multicore cable which will plug into plug and socket boxes mounted on the fit-up legs. These boxes in turn are fitted with multicore cable fed through 2-in. conduit to plug into the floor plug boxes; the F.O.H. spots are wired permanently to the stage switchboard. The boxes in the stage floor also contain the fly plugs and stage displays.

Architects
Slater, Uren and Pike.

Consulting Engineers
Edward A. Pearce and Partners.

Electrical Contractor
Holliday, Hall and Stinson, Ltd.

Lighting Equipment supplied by
Hume, Atkins and Co., Ltd. (Classrooms, foyer).
Courtney, Pope (Electrical), Ltd. (Classrooms, laboratories, arts and crafts, hall).
S.L.R. Electric, Ltd. (Corridors, laboratories, kitchen, foyer).
Benjamin Electric, Ltd. (Gymnasia).
H. C. Hiscock, Ltd. (Staff rooms).
Merchant Adventurers, Ltd. (Staff rooms).
Strand Electric and Engineering Co., Ltd. (Stage lighting and auditorium dimmer).

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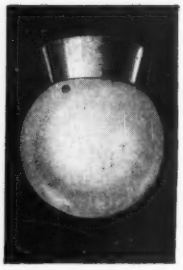

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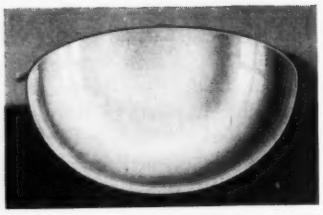

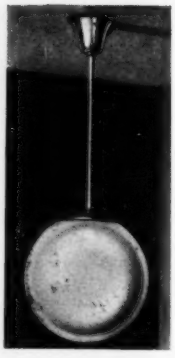

Architects:
SLATER, UREN & PIKE

Consulting Engineers:
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THE LIGHTING FITTINGS SHEWN ABOVE ARE FULLY ILLUSTRATED IN OUR CURRENT CATALOGUE—COPIES ARE AVAILABLE ON REQUEST

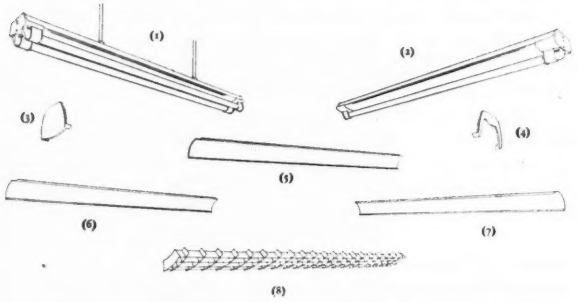
S.L.R. LIGHTING FITTINGS HAVE BEEN ACCEPTED BY THE COUNCIL OF INDUSTRIAL DESIGN FOR INCLUSION IN "DESIGN" REVIEW

Fluorescent Luminaires from Standard Components

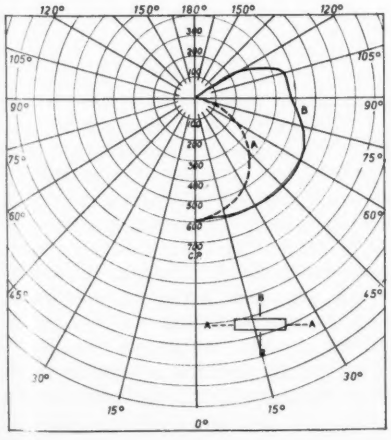
A new range of industrial fluorescent luminaires has been introduced by Crompton Parkinson, Ltd. From two basic designs 54 different luminaires can be made up by incorporating standard fittings such as side panels, end pieces and louvres.

In developing this range (known as the "New-Range") Crompton Parkinson made a comprehensive survey of users' needs and preferences; a study was made of modern building construction details and trends in lighting development, after which a specification was drawn up to meet as many as possible of the indicated requirements. The services of Peter Bell, M.S.I.A., were commissioned in order that good style and line should be obtained. The result is an attractive range of luminaires incorporating many novel features to simplify installation and servicing.

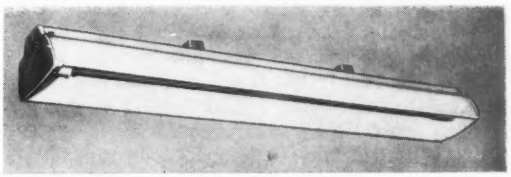
Forming the foundation for the complete range are one-lamp and two-lamp general lighting luminaires which can have base reflectors with either a "Permawhite" high-gloss stoved enamel finish or, for gritty atmospheres, a vitreous enamel finish. From these basic units the range is built up by the addition of light alloy die-cast end plates to which the side reflectors are attached. In this manner open or closed top effects in "Permawhite" or vitreous finish are obtained, or translucent effects with opal diffusing "Perspex." A feature of the open-top reflectors is that there are no obvious apertures to cause discomforting glare; nor are there any projections to interfere with the easy cleaning of the equipment.



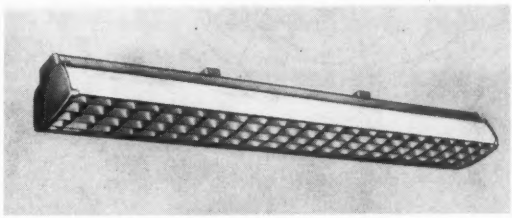
(1) Basic two-lamp unit; (2) basic one-lamp unit; (3) closed end plate; (4) open end plate; (5) 'Perspex' side reflector; (6) closed top metal side reflector; (7) open top metal side reflector; (8) louvre.



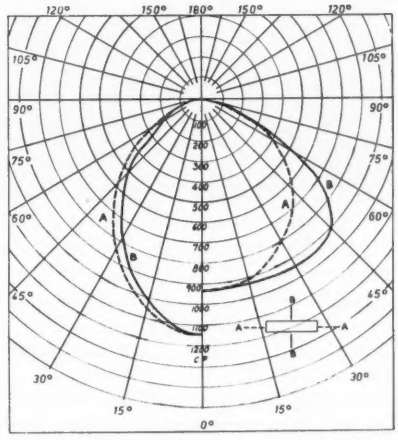
Basic foundation luminaire (AS11). Light output ratio —approx. 85 per cent. One 5 ft. 80-watt lamp (4160 lumens).



Closed top, closed end luminaire.



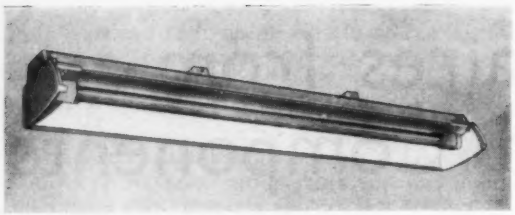
Closed end luminaire with louvre.



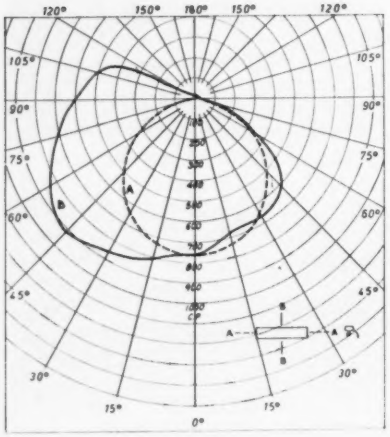
Right side:—Closed top (AC11). Light output ratio — approx. 75 per cent. One 5 ft. 80-watt lamp (4160 lumens). Left side:— With louvre (ACL11). Light output ratio— approx. 57 per cent.

By dispensing with one side reflector a luminaire becomes suitable for the lighting of display shelves, wall charts, etc., whilst, with the full complement of reflectors or a single-side reflector, all the closed-end luminaires may be converted to louvred units by attaching a rigid "Permawhite" finish metal louvre having approximately 25/35 deg. cut-off. For installations where louvres are not required, open-end reflector supports can be fitted in place of the end plates.

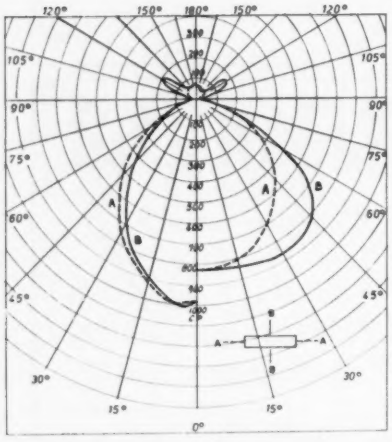
Due to the complete interchangeability of parts,



Luminaire with single side reflector.



Closed top single-sided luminaire (ACS11). Light output ratio—approx. 80 per cent. One 5 ft. 80-watt lamp. (4160 lumens.)



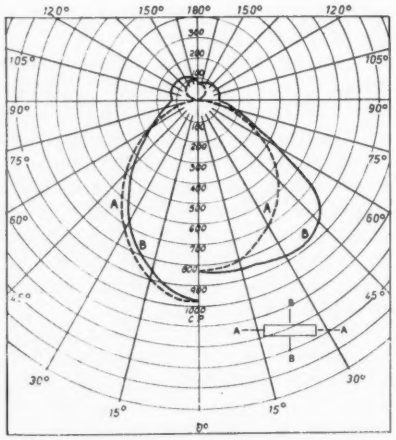
Right side :— Open top with metal side panels. Light output ratio—approx. 77 per cent. (9 per cent. upwards). One 5 ft. 80-watt lamp (4160 lumens.)
Left side :— With louvre (AOL11). Light output ratio—approx. 61 per cent. (10 per cent. upwards).

maintenance of the complete range of 54 different designs can be achieved with a minimum stock of 10 pieces, and, in fact, for most installations immediate maintenance can be ensured with even fewer parts.

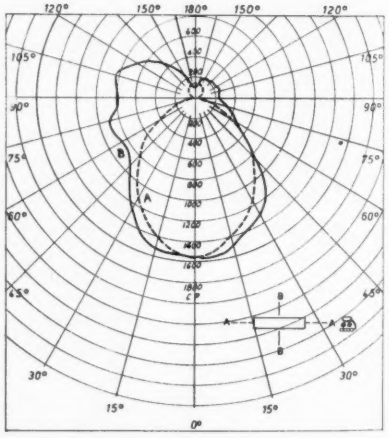
Amongst the features incorporated to facilitate installation are:—(1) Built-in quick-fixing devices for close ceiling mounting. (2) Variable fixing centres for ceiling or pendant mounting. (3) Facilities for earth and earth continuity. (4) Spring-loaded earthed cap contact lampholders with sliding end shields fitted at both ends for simple lamp replacement from either end. (5) Simple removability of reflectors with lamps in position for easy cleaning with complete safety even with the luminaires in use. (6) Simple attachment of louvres without screws, gadgets or extra parts. (7) Readily accessible terminal blocks for mains connections. (8) Ability to attach to conduit, conduit box, chain or any other form of suspension, and adaptability to any form of wiring system.

The fittings are constructed in accordance with B.S.2467.

A point which is likely to appeal to users is that the same family resemblance can be kept throughout an installation that has widely varying demands for



Right side :—With "Perspex" translucent side panels (AT11) Light output ratio—approx. 81 per cent. One 5 ft. 80-watt lamp (4160 lumens).
Left side :—With louvre (ATL11). Light output ratio—approx. 68 per cent.



Single-sided translucent "Perspex" reflector. Light output ratio—approx. 73 per cent. Two 5 ft. 80-watt lamps. (8320 lumens.)

luminaires with different light characteristics, as, for instance, open-top, closed-top, double-sided reflectors, single-sided reflectors, fittings with louvres and fittings without louvres. Moreover, the forms of fixing allow this family resemblance to be maintained even in existing buildings which have many different forms of ceiling construction and which may even have many different materials used for ceiling construction. Another useful point is the easy manner in which luminaires already installed can be modified to meet different conditions, such as when an illuminated area is used for a new and different purpose.

I.E.S. Activities

London

At the London meeting on November 9 Mr. R. L. C. Tate presented a paper entitled "The Lighting of Small and Medium-sized Shops and Stores."

The paper reviewed progress in the lighting of smaller shops since 1949, discussed the various techniques used and equipment available and indicated possible developments. Great ingenuity has been shown and many interesting lighting features are to be found in these smaller stores and specialist shops where, in the past five years a radical change has taken place in the whole conception of lighting. The value of good lighting in both shop windows and shop interiors as a means of increasing sales is now generally realised by architects, designers and shopkeepers.

The purpose of a shop window is to help the shopkeeper to sell his goods, and the type of lighting and display will be influenced by whether emphasis is to be placed on direct selling from the window or on the effect of clever presentation to advertise the shop. Changes in fashion tend to affect the design of window, and interior, lighting, as, for example, in the case of the streamlining of the familiar mirrored-glass shop window reflector and the use of reflector spot lamps. Some classes of merchandise are best lighted by means of tungsten lamps only; a few look well under fluorescent lamps alone, but the majority respond best to a mixture of both. The general brightness of the locality is a factor affecting the amount of light it is necessary to provide; where there is little competition from street lighting and other windows the general level of illumination may be much less than in a busy shopping street.

The paper also discussed the use of louvres and louvred ceilings for shop windows and the lighting of arcades, island windows and open-backed windows. The problem of window reflections was also discussed and suggestions made for avoiding them.

In the majority of shop interiors the lighting should be designed primarily to set off the merchandise, and should not be regarded either as an architectural embellishment or as an unavoidable necessity. In certain classes of shops, however, the creation of an attractive atmosphere is even more important than emphasis on the goods, and in such cases lighting fittings of a purely decorative nature are often found.

The question of whether it is best to provide a fairly high level of general illumination all over a shop or to localise the lighting on display areas and counters, relying on the spill of light to illuminate gangways and floor areas, is still largely unresolved. The type of lighting used depends on the class of goods and the class of customers as well as on the general design of the shop interior. The colour-rendering properties of light sources are more important inside the shop than in the window, for it is there that the customers appraise the goods closely. The paper includes suggestions for the best types and colours of lamps for use in different types of shop based on the results of investigations and on the experience of traders.

Mr. Tate summarised his paper by saying that shop lighting has three main functions—to help sell the goods, to help customers appraise the goods, and to provide a comfortable atmosphere for both customers and shop assistants. Shop lighting is an interesting, exciting and expanding field for the illuminating engineer, but far too many still treat shops merely as large interiors to be lighted.

Bath and Bristol Centre

An unusual I.E.S. meeting took place on September 23 when a joint meeting was held between the Bath Group of Architects and the Bath and Bristol Centre of the I.E.S. at the Electricity Offices, Bath. Three short talks were given by Mrs. R. A. Gerrard, Mr. P. K. Pope, and Mr. H. H. Goldsmith; Mrs. Gerrard dealt with hospital lighting, Mr. Pope with domestic lighting, and Mr. Goldsmith with lighting of schools.

Many interesting and controversial points were raised, including the problems of static electricity in operating theatres, the colour rendering of fluorescent lamps for domestic premises, and the problems of lighting classrooms and avoiding glare while keeping costs to an absolute minimum. These points were first answered by Mr. Phillips and Mr. Robbins, both of whom were guest speakers from London and both of whom were lighting fittings designers.

Some of the members and guests of the Bath and Bristol Centre on a recent visit.

A very interesting, brisk, and at times humorous, discussion followed when many aspects of the problems involved were discussed from various angles.

At the commencement of the meeting the outgoing chairman, Mr. R. W. Steel, handed over the office to Mr. D. E. Beard and wished him a successful year of office. Mr. Steel thanked all members of the committee and secretary, Mr. H. A. Turner, who had by their generous help made the past session such a success.

Earlier in the month a number of members of the Centre, together with their ladies, took part in a very successful visit to the W. D. and H. O. Wills factory followed by a coach trip through the Cotswold country, winding up with dinner at Tetbury.

Leeds Centre

The first meeting of the Centre in Hull was held in the Yorkshire Electricity Board Lecture Room on Mon-

Mannequins at the recent meeting in Hull.

day, October 4, under the chairmanship of Mr. N. Shackleton.

The subject "Modelling with Light and Colour" was given by J. W. Howell, who demonstrated the effect of coloured lighting on gowns and dresses displayed by mannequins. The mannequins and gowns being loaned by the courtesy of Thornton-Varley Ltd., Hull, a leading fashion house in the city. Approximately 130 people were present representing the leading fashion houses, College of Arts and Crafts, and industry of the city. From the remarks expressed and questions asked by various people the lecture was very greatly appreciated.

The chairman, in his closing remarks, expressed the view that the Centre filled a long-standing need for meetings and discussions dealing with this aspect of the trade. A vote of thanks was expressed to Thornton-Varley Ltd., for the wonderful way they had co-operated to ensure the success of this first meeting of the society in Hull.

The holding of meetings in Hull is a new venture by the Centre. Until June of this year there were only 11 members of the Society in Hull. Due to the enthusiasm of Mr. D. G. Hall and Mr. N. Shackleton, who with a local committee have taken on responsibility for Society activities in Hull, the number of members has risen to 36. The success of their first meeting is most encouraging.

Leicester Centre

On October 25 Mr. A. Calvert, of the John Innes Horticultural Institute, gave a lecture to the Leicester Centre on "Artificial Illumination of Horticultural Crops."

Mr. Calvert recalled that during the last few years Nature had been aided by artificial lighting to speed up plant growth and to give earlier forming of fruit. In glasshouses where tomato and cucumber plants were grown professionally the 400-watt mercury vapour lamp had been used with good effect. Illumination values of 300-500 lm/ft^2 were necessary and plants should be illuminated 12 hours per day in winter time, this period of time varying according to the length of natural daylight. Seedlings would normally be subjected to this artificial light for three weeks then removed to make room for more seedlings and placed in a normal glasshouse.

Mr. Calvert quoted figures from independent growers to prove that the capital cost of lighting equipment could be paid for after the first 12 months by the increased and earlier cropping realised. He also discussed photoperiodic control for initiating flower buds in chrysanthemums by means of comparatively low efficiency lamps, i.e., 40-watt clear tungsten lamps suspended over plants.

Members of the Leicester Horticultural Society were present at the meeting and took an active part in the discussion which followed.

I.E.S. of India

An Illuminating Engineering Society has recently been formed in India, with headquarters in Calcutta, with objects similar to those of similar societies in other parts of the world. One local centre has already been set up in Bombay, and it is likely that others will follow. The first president is Prof. M. S. Thacker, Director of the Indian Institute of Science at Bangalore. The hon. secretary is S. N. Chowdhry.

I.E.S. Forthcoming Meetings

LONDON

December 14th

Sessional Meeting. "Maintenance of Lighting Installations," by W. Robinson and J. W. Strange. (At the Lighting Service Bureau, 2, Savoy Hill, W.C.2.) 6 p.m.

CENTRES AND GROUPS

December 1st

EDINBURGH.—"What Do We Know About Lighting?" by R. J. Fothergill. (At the Y.M.C.A. Small Hall, 4, Queen Street, Edinburgh, 2.) 7 p.m.

SWANSEA.—"Lighting for Enjoyment," by T. O. Freeth. (Joint meeting with the Electrical Association for Women.) (At the South Wales Electricity Board's Demonstration Theatre, The Kingsway, Swansea.) 6.30 p.m.

December 2nd

CARDIFF.—"Lighting for Enjoyment," by T. O. Freeth. (At the South Wales Electricity Board's Demonstration Theatre, The Hayes, Cardiff.) 5.45 p.m.

GLASGOW.—"Dock and Railway Lighting," by W. T. F. Souter. (At the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2.) 7.30 p.m.

NOTTINGHAM.—"A New Approach to Lighting Design," by W. Robinson. (At the Demonstration Theatre of the East Midlands Electricity Board, Smith Row, Nottingham.) 6 p.m.

December 7th

STOKE-ON-TRENT.—"Marine Lighting," by T. Catten. (At the Lecture Hall of the Midlands Electricity Board, 31, Kingsway, Stoke-on-Trent.) 6 p.m.

December 8th

NEWCASTLE.—"Fluorescent Stage Lighting and other Applications of Fluorescent Lamp Dimming," by H. H. Ballin. (At the Newe House Lecture Theatre, Pilgrim Street.) 6.15 p.m.

NORTH LANCASHIRE.—"Studies in Interior Lighting," by J. M. Waldram. (At the Demonstration Theatre of the North Western Electricity Board, 19, Friargate, Preston.) 7.15 p.m.

December 9th

MANCHESTER.—"Studies in Interior Lighting," by J. M. Waldram. (At the Engineers' Club, Albert Square, Manchester.) 6 p.m.

December 13th

LEEDS.—"X-Ray Apparatus for Medical Applications," by F. L. Veale. (At the E.L.M.A. Lighting Service Bureau, 24, Aire Street, Leeds, 1.) 6.15 p.m.

SHEFFIELD.—Presidential Address, by E. C. Lennox. (At the Medical Library, The University, Western Bank, Sheffield, 10.) 6.30 p.m.

December 14th

LIVERPOOL.—"Stage Lighting," by P. Corry. (At the Lower Hall of the Liverpool College of Art, Hope Street, Liverpool.) 7 p.m.

December 21st

GLOUCESTER AND CHELTENHAM.—"Lighting of Parks," by H. A. Turner. (At the Cadena Café, High Street, Cheltenham.) 6.30 p.m.

December 30th

BIRMINGHAM.—Display of New Lighting Fittings. (At the College of Technology, Suffolk Street.) 6 p.m.

Street Lighting for Kuwait

During recent years, Kuwait has achieved a new prosperity and unexpected prominence. Consequent on the signature of an agreement with the Kuwait Oil Company, which brought vast reserves to the State, a decision was made to replan completely the old walled town and expand it into the surrounding desert.

Among many other considerations, the question of suitable street lighting for the new town had to be solved. The architects prepared several designs and models of street lighting units from which acceptable columns and lanterns were evolved. Tenders for equipment were invited from both British and foreign electrical firms; it was stressed that a complete "breakaway" from conventional design was required and that the equipment must be able to withstand tropical conditions as well as sand storms.

From the tenders submitted a contract for nearly £100,000 of Class "A" fluorescent lighting units was awarded to Siemens Electric Lamps and Supplies Ltd. of Great Britain. Involving all main roads and an additional 500 units for Class "B" side roads, Siemens equipment will be used throughout the replanning of the town except for special fittings to be supplied by the Revo Electric Co., Ltd.

Columns for main and secondary roads are to be of the circular galvanised steel type manufactured by Poles, Ltd. They will be finished in bright colours to contrast with their surroundings.

A special manufacturing design team was formed by Siemens to implement their contract. Headed by Dr. J. N. Aldington, a team of specialist lighting engineers developed the selected designs and provided a lighting layout for the proposed new town involving 2,000 lighting points. The scheme was based upon the B.S.I. Code of Practice suitably adapted for local conditions.

Optical control systems for the various types of lanterns were designed and prototype lanterns were fabricated to determine tooling requirements; inside a special tropical research room, the lanterns were subjected to conditions of heat and humidity identical to the Kuwait climate. In addition, lamps, control-gear, paints and varnishes were subjected to prolonged tropical tests which, in a number of instances, necessitated special designs for certain components. One development of these tests resulted in a new starter-switch, whilst the actual paint finishes experimented with resulted in a new heat, light, and corrosion-proof finish which Siemens have named "Haliglass." At Siemens Woolwich Works, the question of special high temperature and corrosion resisting cable was reviewed, and a plastic covered cable for use with the lighting units was produced.

The roads in the new town vary in width from 12 to 50 metres. On the wider roads lanterns accommodating three 5-ft. 80-watt daylight lamps will be used with two-lamp lanterns on the 30-metre-wide roads. These 5-ft. lanterns will be given a slight tilt to preserve the smooth line of the columns.

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POSTSCRIPT By "Lumeritas"

Although many of our streets are inadequately lighted, this country is certainly a leading one in the matter of street lighting. Aberdeen can claim the first installation in the world of cold cathode fluorescent street lighting. This installation, described in this journal some months ago, was also noted in one of the architectural journals, although not without the expression of some doubt about the aesthetic merit of the installation because the lanterns are attached to the buildings themselves. It was admitted that as far as illumination goes the system seems to work very well, and—from a photograph—"the thing looked reasonable enough because you could not see the buildings for the lights." With all due respect to our architect friends, I suggest that this concealment will sometimes be a point in favour of the system, although I readily concede that there are streets where it will be otherwise. Is there not a case for bearing in mind this method of mounting street lanterns when new buildings are designed? Building interiors are sometimes designed with in-built lighting or with a particular method of artificial lighting in mind, and building facades might well be designed to accommodate street lanterns without detriment to their appearance—so enabling lamp-posts to be dispensed with.

Earlier this year I mentioned a suggestion by a Norwich correspondent that different classes of roads might be distinguished by the illuminant used for lighting them—sodium lighting being selected for class A roads. If this suggestion has any merit, it seems unlikely to be followed while the lighting of these roads is the concern of so many local authorities whose views do not coincide. Two neighbouring boroughs in the provinces are now considering collaboration in lighting a section of a new main road which runs between them. One borough already uses mercury lamps and is very proud of its street lighting, but the other borough, which will actually be responsible for the installation work on the new road, proposes to use sodium lamps—apparently because they have been found slightly cheaper to maintain. Each borough has to provide 25 per cent. of the cost of lighting the new road, but the mercury borough insists that its preferred lamps be used. The Ministry of Transport bears 50 per cent. of the cost of the installation, but the local contributors must argue the case of mercury v. sodium between themselves and may be expected to apply the judgment of Solomon—each taking half of the road stretch and backing its fancy!

Complaints of asthenopia ("eyestrain") under fluorescent lighting have been investigated in Switzerland as well as in this country and, according to Professor H. Schober—who published a paper on this subject some time ago—the conclusions reached are much the same as have been reported here. Complaints about fluorescent lighting fall into two categories, namely, those which arise immediately after installation of the lighting—"initial complaints"—and those which either do not appear until the fluorescent lighting has been in use for at least six months or are initial complaints which persist longer than six months. The initial complaints, as well as many of those in the second category, are primarily expressive of resistance to innovation. Genuine psychoses may develop but it has been found that these may be resolved "by simple questions by experts" to the complainants. The number of initial complaints decreases as fluorescent lighting becomes more prevalent and therefore commonplace. Not all of the more persistent complaints are symptomatic of psychoses—some are due to faults of lighting design such as glare, or to special circumstances such as frequent passage between tungsten and fluorescent lighted rooms. Another factor mentioned by Prof. Schober is the psychological association between light colour, distribution and strength of illumination, especially in the case of "daylight" lamps. Here the colour and distribution approximate to those of daylight, whereas the level of illumination is only that of ordinary artificial light. The result is an impression of pale (i.e., fading) daylight, so that inadequate illumination is imagined. This impression disappears at once if the illumination is suitably increased or if fluorescent lamps giving "warmer" light are used. Exhaustive experiments have shown that with a 50-cycle supply there are no visible flicker phenomena, and that the sub-threshold light fluctuations have no effect on the eye and cannot, therefore, be a cause of asthenopia. The possibility of conjunctivitis or of damage to the eyes due to emission of ultra-violet radiation is completely discounted and, if any fluorescence of the crystalline lens arises from near ultra-violet radiation, it is harmless and not disturbing in adequately illuminated rooms. As far as I know, the ill-effects which some people impute to interior fluorescent lighting are not alleged against fluorescent street lighting.

While on the subject of complaints about lighting I will risk boring my readers with a further reference to "visual discomfort." Mr. Logan, whose letter on this subject I quoted in September, has written me again with an assurance that—at least on his side of the Atlantic—people who complain that lighting is causing them discomfort always mean that the lighting is glaring. "In fact," he says, "the subject of visual discomfort did not arise in the popular mind over here until lighting levels had reached that level of adequacy that the refinements of brightness control could be promoted, and so it is popularly associated with brightness contrasts." Looking through the Transactions of the American I.E.S. I find—as far back as 1925—that Drs. Ferree and Rand wrote of "ocular discomfort" as if it arose only from excessive brightnesses in the visual field. In this country we often speak of "glare discomfort" when we have in mind "ocular" or "visual" discomfort due specifically to glaring lighting and not to other conditions of lighting which can also cause discomfort in seeing. This is better than using the wider or looser expression "visual discomfort" as if it could only mean an effect of glare. I think Mr. Logan appreciates this point since he says, "Perhaps there would be less confusion if we went back to the original nomenclature and called what we were talking about over here the psycho-physical response to direct glare," although I agree with him when he adds that the layman would not then know what we were talking about!

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